DISCOVERY

A Monthly Popular Journal of Knowledge

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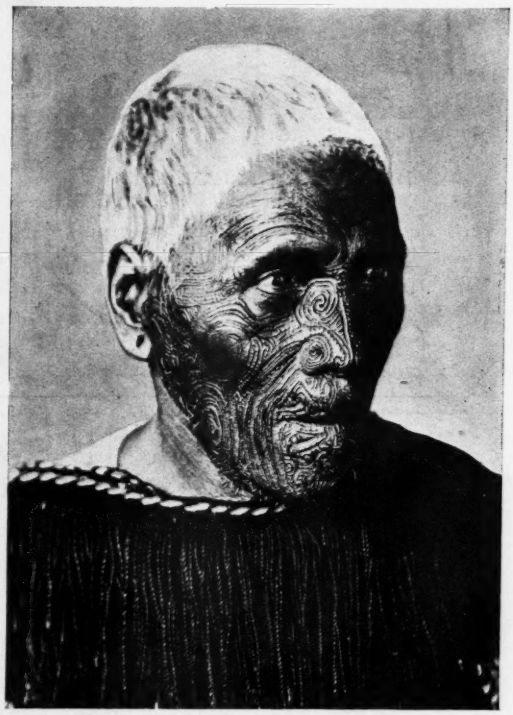

A TATTOOED MAORI CHIEF.

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Editorial Notes.

One of the most interesting discussions of recent times was that at the Conference of Modern Churchmen at Oxford on the subject of "The Scientific Approach to Religion." It may perhaps be found in years to come that this particular conference was something in the nature of a landmark, or rather a turning-point, toward a mutual readjustment of the old vexed problem of the relation of science to religious doctrine. Professors Haldane and MacBride were invited to address the conference, stating as clearly as possible modern thought on evolution and vitalism. The President was the Very Rev. W. Inge, Dean of St. Paul's. The conference led to no very clear conclusion, for such vast speculations on the nature of ultimate things are not in their very nature susceptible of proof. That which did emerge most clearly was that science, as we interpret it to-day, is not incompatible with true religious thought and experience.

* * * * *

The whole question is one of paramount importance, for it is in the nature of man to seek in religion those certainties which we are accustomed to associate with science and scientific proof. The difficulties of reconciling abstract doctrines with facts which appear (so far as our limited human capacity for interpretation of them can be trusted) to be incompatible, weigh more heavily on those who are neither philosophers nor scientists than on the profounder thinkers. The scientist and the priest enjoy common qualities, those of Faith and the desire of Truth. Two generations ago the enunciation of the evolutionary doctrines of the time was the signal for an embittered campaign by many well-meaning upright folk who held that their most cherished beliefs were challenged. There were heavy battles about the Old Testament, assault and counter-assault on dogma. To-day the dust of those conflicts has settled and survivors and descendants of survivors see more clearly. Beyond science and beyond religion stand the true values Truth, Goodness, Beauty, the mighty conception of Eternity. Beyond all—God, the Absolute. There is no incompatibility in these vital matters. Nothing in science has overturned the claim of religion that these are essential permanent values and nothing in religion challenges the positive facts determined by science in its analysis of vital phenomena. Neither side has yet evolved a complete system. If scientists disbelieved in a thing because there was no proof of it, there would be no progress in science. It is this very faith in the speculative, the unproven, and the hope that their dream or theory may be proved to be true, that is the urge which leads them to seek truth.

* * * * *

The conference will have done useful work if it succeeds in demonstrating to the clerical and lay world that there is no need to look on science and religion as antagonists, but rather as independent roads leading in the end to the same far-distant goal.

* * * * *

Livy has been the sensational event of the past month and the reported discovery of the missing books has created almost as much general excitement as Tut-ankh-amen's tomb. The peculiar reticence of the young Italian professor produced a condition of excitement and suspense in academic circles that can

only be compared to the conditions prevailing in racing circles when rumours go round that a stable is going to scratch an important runner in a really big race. The one thing that nobody could find any decent explanation for was Fusco's behaviour. Why should he behave like a petulant child when asked by perfectly reputable people to show what it was that he had found? For several weeks the only real facts emerging from the whole boiling of rumours and speculation were (*a*) that there were known to have existed more books of Livy than we have complete copies of at present ; (*b*) Fusco, though young, had a good reputation as a scholar in this particular field of knowledge.

* * * * *

The world at large cannot be blamed for being sceptical about any reported discovery news of which comes from Italian sources. Fleet Street knows well that astonishingly large allowances have to be made for the ebullient Latin imagination, and that the facts are apt to founder under an incandescent load of adjectives and general embroidery. They sent their own men to get the facts and Fusco—Fusco took to the hills. The Italian police pursued inquiries, for the alleged find was presumptively Government property, yet despite the teachings in criminal psychology and criminology of the school of Lombroso and Ferri these sleuth-hounds who can fathom the mysteries of the Mano Nero, the Cammorra and the Mafia were baffled. The property—estimated at about 14 cwt. of parchment rolls—also eluded searchers.

* * * * *

For the moment the world had to wait. Fusco, whose reputation for veracity had not been enhanced by his flight (and his abandonment of his old mother, who was left to answer inquiries), telegraphed to the Royal Academy of Naples saying he would be there on the sixteenth of September and would disclose all. During the week of suspense two assurances were given to the world by sound authorities. Firstly, it was denied that a Life of Christ dated 58 B.C. had been found, secondly it was denied that Livy's name was really Levi and that he had emigrated to Rome from Palestine.

* * * * *

On the eventful day Fusco, instead of appearing, wired to the Prefect of Naples that all he had found were notes by an unknown scribe stating that he had been appointed to transcribe the works of Livy, and that the inquiries made had disturbed his peace of mind. We are not inclined to waste much sympathy over Fusco's nerves or lack of moral courage. He could have made the position clear at any time, but preferred to let the world wait, not for a great dramatic denouement in which the missing manuscripts of Livy would be open to the scholars of the world, but for this pitiful disclaimer. It is not a trick which can be played twice. If Fusco took a burnt cork and besmeared the face of every man of letters in Italy he would have insulted individuals. As it is, he has insulted not only his own countrymen, who probably feel more acutely on the matter than we do, but he has offended learning throughout the world. He, a professor, has done more to damage the general standing of his country than the wildest political excess. Politics are a domestic trouble, but knowledge is international. Our sympathy is with Italy in this matter, and perhaps we can only judge the affair partially for Fusco alone knows the truth. There is no remedy, but one wonders if the rods around the axe which symbolise the Fascisti are purely decorative. Anyway, further stories of great discoveries sponsored by Italian professors will leave us as cold as the gurgle of cold water in an embalmer's room. As the waiter at the Café Borgia puts it, "*Fusco—— 'e finish.*"

* * * * *

I want to thank the many readers of DISCOVERY who have so kindly sent in the names and addresses of potential readers of our paper. It has been extremely useful and the great majority of new readers so recruited have become subscribers and, I hope, friends. The campaign is doing a great deal of good and I ask you not to relax your effort. *We will send a free copy of* DISCOVERY *to anybody anywhere in the world where some kind of postal service can get to him or her. Send us a postcard with the name and address.* Have you ever considered how important the paper is to our overseas readers? We see it in the office. We get long delightful rambling letters from the ends of the earth—some reader who is beyond civilisation and who finds DISCOVERY a link between which keeps him in touch with all that is going on in the progress of knowledge—"The nearest white is three days' journey away and he is a small trader. Next to my home letters DISCOVERY is the most important thing in the mailbag for me. You cannot realise what a blessing it is to have a paper like yours in a place like this where a man with some small scientific training is alone. It is like having clever friends to talk to." No more eloquent thanks could be bestowed on those who write for DISCOVERY than those few words. If we are doing this we are fulfilling the object of the paper.

* * * * *

An excellent suggestion comes from a member of the Royal Society. He has started a postscript campaign for DISCOVERY. To the end of letters he adds "Do you read DISCOVERY? If not get it !—12/6 a year post free." Copy his example.

Mediaeval Life in an Oxford College.

By A. H. M. Jones and K. McGregor.

This article throws interesting light on conditions of life at the University during the Middle Ages. New College was built 1830-86.

A good deal can be recovered of life in Oxford colleges during the 17th and 18th centuries from the diaries of Antony Wood, Hearne and other worthies of the period; but very little literary material exists for the Pre-Reformation period, and not much use has hitherto been made of what other evidence there is. In the following article an attempt has been made to reconstruct to some extent the conditions under which the members of William of Wykeham's great foundation of New College, Oxford, must have lived in the first century and a half of its existence.

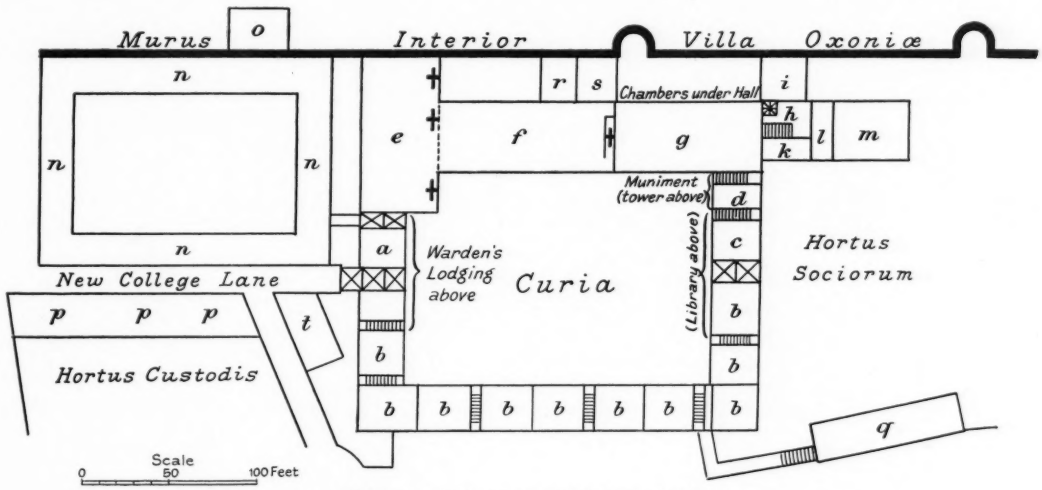

Fig. 1.—ORIGINAL PLAN OF NEW COLLEGE, OXFORD.

Our evidence is drawn from three main sources—the Founder's statutes with the Injunctions of early Visitors, non-literary documents such as the Bursars' Rolls together with passing references in the University and City records and, thirdly, the original structural arrangements so far as these can now be recovered by a careful study of the present buildings in the light of early drawings and prints.

A glance at the accompanying plan (Fig. 1) will show clearly enough the completeness of the original design. To the north of the gateway was the porters' lodge (*a*) where the two porters lived and probably slept. It was commonly called not *domus janitorum* as we might expect, but *domus barbitonsorum*, for the mediaeval porter had also to serve as college barber. In the gate-tower and over the porters' lodge was the warden's lodging (*custodis hospitium*). The southern half of the quadrangle and the ground floor under the hall was given over to the chambers (*b*) of the seventy fellows, ten priests, three clerks and sixteen choristers who, together with the warden, made up the foundation. Along the east side on the upper floor was the library. The room under it to the north of the east gate was then, as now, used as the bursary (*c*). North of the library was the four-storied muniment-tower (*d*). This was used as a general repository for the college treasures—title-deeds, plate, etc. All the rooms are fire and weather-proof; they are vaulted, with tiled floors and heavily barred, glazed and shuttered windows. The doors are plated with iron, and each one is secured by a most elaborate system of locks.

Along the north side ran the long line of buildings comprising the antechapel (*e*), chapel (*f*), hall (*g*), and kitchen offices. The arrangement of these last was ingenious. Three doors led out of hall—one to the buttery (*h*), whence a spiral stair gave access to the cellar (*i*), another to the pantry (*k*), now disused, and a third to the broad staircase going down to the actual kitchen (*m*). Over this stair was a long room (*l*) connecting with both buttery and pantry. This was

probably the office of the manciple (*mancipium*), an important functionary who was responsible for the catering arrangements. At the beginning of the 16th century, at any rate, he was assisted by two butlers (*pincernae*), while the kitchen staff consisted of three cooks (*coqui*), the chief of whom received by far the highest wage of all the servants.

West of and distinct from the antechapel lay the cloister (*n*), the private burial ground of the society, with the bell-tower (*o*), which later contained the clock. Finally, opposite the cloister, on the south side of New College Lane, was the range of buildings (*q*) which included the stables, brewhouse, and tithebarn; The garden, too, in the words of Warden Woodward (died 1675), "ancyently was for onyons, leeks, etc." and "not for pleasure, & walking, but for Profitt."* According to the same authority there were also fruit trees, and vine poles figure in the Bursars' Rolls.

Self-supporting Establishment.

With the college estates to draw upon for raw materials the Society must have been practically self-supporting—a state of affairs not entirely satisfactory to Oxford tradesmen, to judge from their complaint of 1532 that "New Colledge and Magdalen Colledge baketh theyr bread within them, and they have motton, beefe, and all salte store, that is to saye, saltefish, and all theyre cloth for linnens with all other necessaries of household of theyre own provision within them, soe that the Towne is not profited by them." The larders and storehouses for all these things seem to have occupied the site of the present garden quadrangle.

Coming up from Winchester, which Wykeham designed to be a nursery for New College, the juniors, ranging from fifteen to twenty years of age, remained for their first two years at the college on probation as mere "scholars," after which, if their conduct had been satisfactory, they were admitted as full fellows, and became eligible for the college offices. As the warden, like an abbot, kept up his own establishment, there was an annually elected subwarden, answering to the monastic prior, who was in practice the administrative head of the community. There were also five deans, three bursars, tutors (*informatores*), and a steward of hall who was elected weekly.

All these offices were paid and they must have been a very welcome supplement to the meagre resources of the ordinary fellow. The foundation was essentially for poor men. No one whose income exceeded five marks (£1 13s. 4d.) was admitted to the Society. Once they became members they were given weekly commons—nominally a sum of money "to be expended by the bursars and steward," actually their meals—and a yearly livery (*liberata*)—i.e., the scholar's gown. But there seems to have been no provision for pocket-money, though loans could be made from the common chest, and extraordinary expenses such as those connected with the taking of degrees and holy orders were paid out from the same source.

Fellows' Rooms.

The fellows lived in nineteen chambers in the southern half of the quadrangle and one under the hall. These chambers in course of time acquired picturesque names such as "the Green Post" and "the Baptist's Head."* According to the 52nd rubric of the Statutes three fellows were to live in each of the upper chambers and four in all the lower except one ("The Chamber of Three"); and in every chamber there was one fellow senior to and responsible for the rest. Fig. 2 shows the plan of a typical pair of ground-floor chambers as revealed in the light of a careful study of the

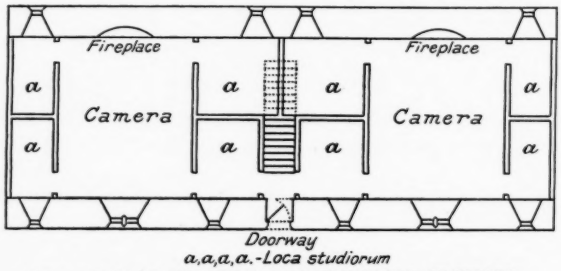

FIG. 2. PLAN OF TWO TYPICAL GROUND-FLOOR CHAMBERS.

structure; Fig. 3 is a photograph of the only large window which still preserves the original tracery. It will be seen that each chamber proper had four studies (*loca studiorum*), each with its own narrow window; the upper chambers, which were approached by a steep stair of one flight, had of course only three.

The fellows slept in the chamber proper, the juniors on truckle beds which in the daytime were put under the taller bed of the senior. In the morning they were awakened at about 5 a.m. by the porter knocking on the door of the staircase with a wooden mallet. How thoroughly they washed may be gathered from the words in the Statutes: "ne quis in superioribus cameris . . . caput, manus vel pedes . . . lavando . . . effusionem faciat." The water for washing was drawn from a pump outside the Conduit Chamber. The sanitary arrangements were, for the time, advanced. The Longhouse (*q* on Fig. 1) is a

* From an unpublished MS. recently discovered by the authors.

* We have identified three of these—the Conduit, the Vale and the Chamber of Three.

large two-storied building, the upper floor being lighted by twelve tiny windows and approached by an outside staircase ; the lower floor has no outlet, being simply a pit, which was periodically cleared.

The chambers would have looked bare to our eyes. The partitions were of lath and plaster ; the floors of the lower story were probably beaten earth ; the windows were unglazed and fitted with stout shutters of which the rebates and hooks in some cases survive. It is uncertain whether there were fireplaces originally, but they have appeared by the middle of the 15th century.* Furniture was scanty, as it had apparently

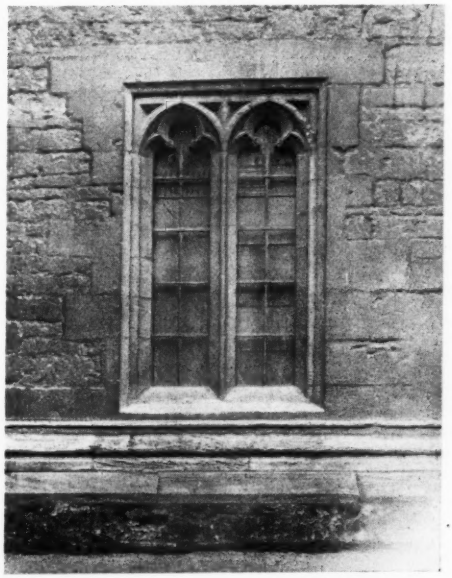

FIG. 3.—THE ONLY REMAINING ORIGINAL WINDOW.

to be provided from the fellows' private means. Besides the bed it would include a stool and desk in the study and perhaps a chest for storing books and other valuables.

Poor scholars who could not afford their own books were allowed to borrow texts from the library, which was primarily intended for purposes of reference. It was divided from the chambers to the south by a stone party wall, instead of the usual partition, as a precaution against fire. Being an exceptionally large library for the time—the Founder himself gave it over two hundred books—precautions against theft were also necessary. Hence an elaborate system of three locks to the door ; one of them—"tertia serura 'clickett' vulgariter nuncupata"—to which every fellow possessed a key, was kept locked even in the daytime. The windows were barred and shuttered, and also glazed, for rough weather was another enemy to be reckoned with. Fig. 4 shows part of one of them recently uncovered by the authors before and after excavation.

* A drawing in the Chaundler MS. (*c.* 1460) shows chimneys.

Beer Breakfasts.

Breakfast (*jentaculum*), consisting of a hunk of bread and a pint of beer, was obtained from the buttery for consumption in the chambers. The other two meals of the day—*prandium* and *coena*—were taken in hall. The meal was preceded by a long grace, with versicles and responses, and a clerk read from the Vulgate, another monastic usage. The sixteen quiristers and the other two clerks served the rest of the foundation. Fig. 5, from the carving over the buttery hatch, shows the quiristers bringing up the beer in the great blackjacks, some of which are still preserved.

Besides being the place for meals the hall was all the common-room the Society had, and Wykeham found it necessary to forbid all loitering there after meals, except on feast-days, when a fire was allowed (in winter), and "poems, chronicles of kingdoms and the wonders of this world and other things befitting

FIG. 4.—BARRED LIBRARY WINDOW.

the clerical state" might be read. But at no time were "wrestlings, dancings, three-steps (*tripudia*), leapings, singings, shoutings, tumults, and inordinate uproars" permitted, lest the inhabitants of the chambers under hall should be disturbed.

Far more important in the eyes of the Founder was the chapel. Ten priests, three clerks and sixteen quiristers were allotted to its service. All the hours and seven masses had to be daily said or sung, and there was also apparently a daily procession round the cloister ; all the services followed the regular Sarum use. All the fellows and the warden himself

were bound to attend at least one mass each day, during which they had to repeat fifty *aves* and five *paters*, after the manner of the modern rosary. Obits of the Founder and benefactors were to be carefully observed.

Of course the chapel presented a much richer appearance then than it does now. There were three side altars besides the high altar; all would be of the ordinary English type. The fine contemporary glass now survives only in the antechapel. Most of the woodwork of the stalls and screen has perished, but the gates of the screen and many of the misericordes remain; on one of the latter seems to be the earliest known representation of part of the college building, the west end of the chapel being almost certainly indicated (Fig. 5). There was an organ* and an organist (*minister dirigens organa*); he had also charge of the

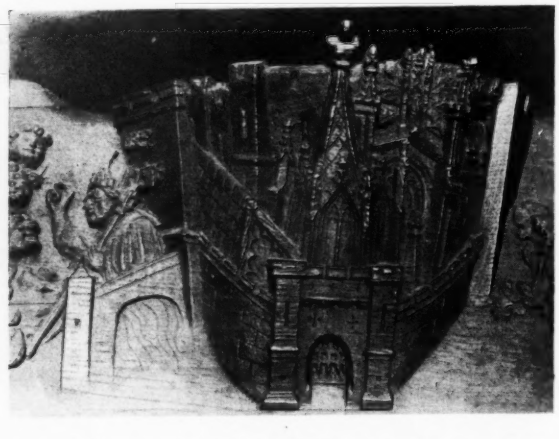

FIG. 5.—CARVED REPRESENTATION OF THE COLLEGE ON ONE OF THE MISERICORDES.

clock, and the task of carrying the fellows' books to the schools. Over the choir was the *informator choristarum*, but both priests and clerks must have been competent teachers of plainsong, as they had to instruct the fellows in the art. Out of the priests were elected a precentor and a sacrist. The latter had the care of vestments and other ornaments; these must have been numerous, for in 1450 we find recorded a gift of fifty copes from a single benefactor. Priests, clerks and quiristers were all lodged in the chambers under the east end of the hall; their quarters must have been uncomfortably cramped.

At the head of the whole was the warden. From his room over the gateway—the traditional lodging for the head of a house—he could survey all comers. North of it he had another room with a beautiful oriel window looking into the quadrangle. Beyond that again was probably his oratory, with a squint into the antechapel. His establishment was quite independent of the rest of the college. He had his own kitchen in his own yard and his own garden. His income was £40 a year—which was princely compared with that of the Master of Balliol, who only got 40s. The Founder was clearly anxious that the dignity of his foundation should be worthily upheld by its head.

* Its removal in 1551 is noted in Warden Woodward's MS

RE APPEAL FUND.

The Trustees acknowledge with cordial thanks the following further response to their Appeal, the objects of which were fully stated in the August number.

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THE GODDARD ROCKET.

MANY criticisms of the idea of the Goddard rocket have been put forward by correspondents. The first and most common objection is that in a vacuum or very highly rarefied space such as we assume the inter-planetary ether to consist of, the gases emitted by the rocket would have nothing to impinge upon and so would fail to push the projectile.

The Professor has demonstrated this fallacy by pivoting a revolver on an axis and firing it with a blank charge in vacuum. The experiment provides practical proof that the kick or recoil from gas expansion exists no less in vacuum than in air.

In practice a small model of the Goddard rocket's gas-producing mechanism was placed in contact with a pressure-registering device which would make a permanent record of the energy produced by the upward driving power of the device. The whole was enclosed in a specially constructed tank consisting of some twenty-four feet of wide-gauge piping looped in a circle to prevent gas-rebound effects. The pipe was then exhausted to one fifteen thousandth of atmospheric pressure, and repeated experiments showed that a rocket exerts 20 per cent greater lifting force in a vacuum than it does at atmospheric pressure.

The apparatus usually illustrated as the Goddard rocket is not the complete rocket itself, but the model used in these preliminary tests.

Why a Cat Falls on its Feet.

By J. C. Chaston, A.R.S.M., B.Sc. Lond.

Have you ever thought about this? Can you say off-hand why cats possess this useful knack? This article explains how it is done.

FROM the earliest times man has remarked that a cat always falls on its feet, and many explanations—some romantic, some merely futile—have been put forward to account for this.

Of the former, an interesting example is the story of the cat and the magician. This story tells how one day a great magician was sleeping beneath the shade of a tall tree. His cat was amusing itself among the branches, no doubt in search of feathered prey, though the original story is not particular on this point. As the magician slumbered, a large and poisonous snake made its way towards him, and was about to strike when the intelligent cat up aloft observed the danger in which its master stood. Without a moment's hesitation it leapt on the snake, and, alighting by good luck on its feet, was able to scratch the reptile's eyes out. The magician by this time was wide awake and his first act was to kill the snake. Then, turning in gratitude to the cat, he, by means of his magic powers, gave to it and its descendants the gift of always alighting on their feet. One may perhaps be pardoned for imagining that this gift was not altogether disinterested, but was awarded to ensure the cat falling safely should a similar danger again menace the magician. Be that as it may, the story is silent on this point, but ends by solemnly inviting all and sundry to examine the truth by experiment. Cats always fall on their feet—hence the story must be true.

But this specious "proof" will hardly satisfy the modern reader. Some other more plausible explanation is required.

Cats' Gravity.

It has been suggested that the reason for a cat always alighting safely on its feet lies in the cat's low centre of gravity. Perhaps the best way to disprove this is by means of a simple experiment. Take a top-heavy object, a carving knife will do very well, and allow it to fall in different positions. If the knife be dropped handle downwards, or blade downwards, or in any intermediate position, it will be found that it continues to fall in that position. The knife will exhibit no tendency whatever to revolve, providing it be carefully dropped. Every part of it will move at the same rate. The blade or the handle can be made to strike the floor at will.

But now try the cat (if you do not mind scratches). By dropping it upside down you cannot make its back strike the floor as the blade of the knife can be made to do. The solution evidently does not lie in this direction.

Another suggestion that has been advanced is that the cat pushes on its support as it is leaving it. This causes it to revolve, and, with luck, to fall on its feet. But puss *always* alights the right way up, and so this explanation is at once discredited. It is not even part of the truth, for if you carefully hold a cat on its back and then suddenly slip the hands outwards and away, the cat will still land on its feet. In this case it cannot have given itself a twist, for there is nothing on which to get a purchase.

How *is* it Done?

No—none of these explanations, which at first seem so plausible, fit in with the facts. Some other explanation is required. What actually happens is that the cat, by some marvellous instinct, performs a series of motions with its legs and body, somewhat like physical jerks, whilst it is falling. The result is that the animal rotates, and the jerks are continued until it has turned the right way up.

To understand exactly what happens during these evolutions, we must first obtain a clear idea of the result of the animal endeavouring to twist itself round whilst it is in the air.

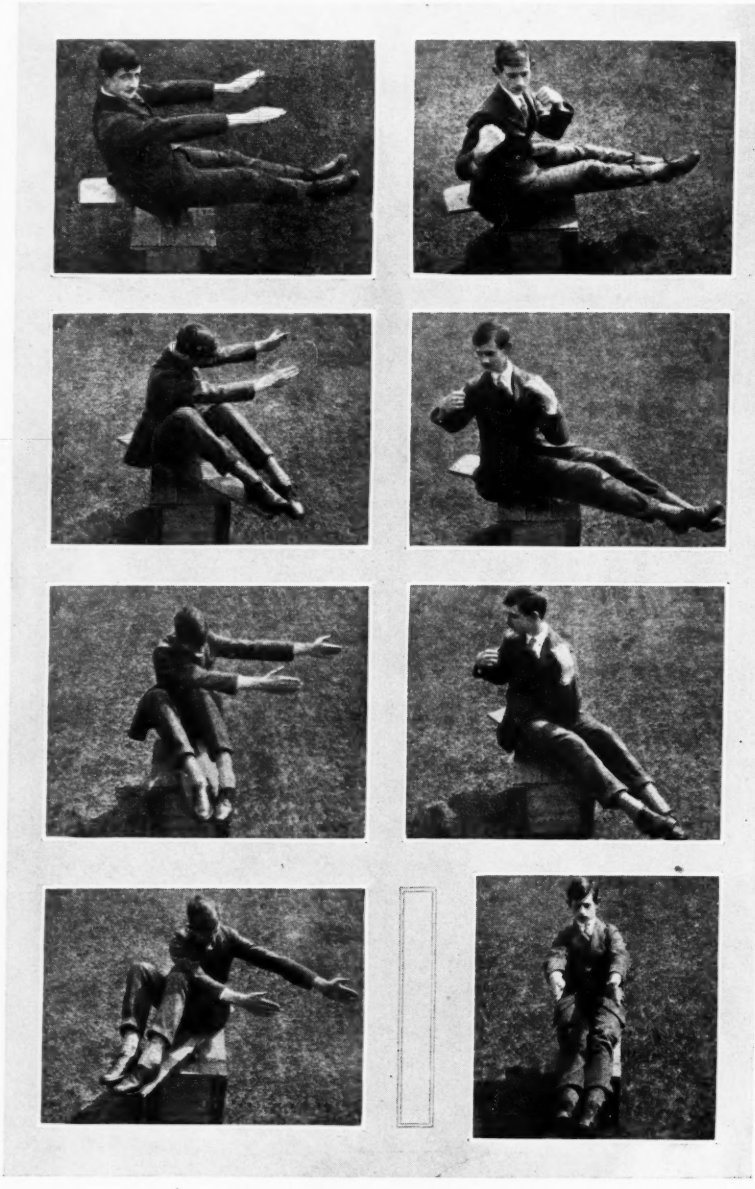
Suppose the cat uses its muscles to turn its fore portion in a clockwise direction. Then its hinder portion will twist in an anticlockwise direction. It is like a piece of twisted elastic. Both ends tend to twist in opposite directions. It is important to recognise that the force exerted by the muscles is the same in both directions, and that just as much force is exerted in turning the fore portion in a clockwise direction as in turning the hinder portion in an anticlockwise direction.

We have next to consider how much each portion of the cat's body will turn under the action of these two equal forces. By means of elementary mechanics it can be shown that the amount of turning depends on what is called the Moment of Inertia of each part.

We are now in a position to understand how the cat turns round. Perhaps the best way to explain this is by reference to the photographs, which show

how a boy seated on a turntable can cause himself to rotate without touching any external object. By turning these photographs sideways a good idea of what happens while a cat is falling may be obtained. No. 1 may be considered, then, to represent the cat at the moment of being dropped upside down, its paws sticking straight up.

The cat at once draws up its front paws and gives itself a turn so that its fore portion goes to, say, the right. Now by drawing up its front paws, the moment of inertia of the front portion of its body is made less. Thus, the angle turned through by this portion is greater than it would have been had the paws been extended. A given force will knock a light body farther than a heavy body, and similarly it will rotate a body having a small moment of inertia through a greater angle than one having a large moment of inertia.



WHY A CAT FALLS ON ITS FEET.
These photographs should be read from left to right consecutively, and illustrate the mechanical movements performed by the falling cat.

The result of the first movement is shown by the second photograph. As shown in the third photograph, the next movement of the cat is to shoot out its fore paws, draw up the rear paws, and twist back in the reverse direction. This time the fore portion, having increased its moment of inertia, does not turn back quite so far as it previously turned forward. Similarly the rear portion, having a smaller moment of inertia than before, turns to the right more than it previously turned to the left. The cat as a whole has thus turned slightly to the right. By continuing these motions, as shown in the photograph, the cat eventually turns itself round until its paws are pointing towards the ground. Thus it lands on its feet.

The motion somewhat resembles that of a man walking on slippery ground. He takes a step forward with his right foot, and his left foot slips back. He then takes a forward step with his left foot, and his right slips back. But, if the distance each foot goes forward is greater than the distance it slips back, the man will go forward. So in this case—the amount that each portion of the cat's body turns to the right is greater than the amount it turns to the left.

The Iron-Bacteria.

By David Ellis, D.Sc., Ph.D., F.R.S.E.

Certain waters contain minute organisms which colour all submerged objects rust-red. This is the work of iron bacteria. Outbreaks of iron-bacteria in drinking water systems are one of the interesting problems faced by the water supply engineers of big cities.

With the exception of those persons whose business it is to make an accurate study of the organisms called *bacteria*, there are not many, even intelligent people, who with the mention of this term can conjure up in their minds an accurate conception of what the biologist means when he uses the term. Bacteria and microbes and disease-producers are with them almost interchangeable terms. To the ordinary person a microbe has no business in life except to catch the unwary human when he is run down, and make things miserable for him. He also envisages the microbe as a tiny *animal*. As these ideas are either wholly wrong, or present only half the truth, we must, before discussing the iron-bacteria, correct these wrong impressions and state with precision the meanings that are attached to the terms *bacteria* and *microbe*. The latter term, which simply means "small life," is given to any very small organism, whether belonging to the animal or to the vegetable kingdom. It is a general term in common use and confusion has arisen because the general has become confused with the particular; in other words, the term microbe, meaning any organism that is very small, has become confused with one particular class of microbe, namely, the bacteria. Now the term bacteria is applied to a definite group of organisms, as definite as say the group included under the term *spiders*, or the term *grasses*.

Useful Bacteria.

The group known as bacteria, which belongs to the vegetable and not to the animal kingdom, embraces all the organisms which have certain qualifications. Some of them fasten on the human body and produce various diseases; others live a very useful life in the soil or in the sea. Whilst the majority are either harmless or extremely useful—regarded from the human standpoint—the minority, about one in every forty, is responsible for certain diseases. Again, we see the same tendency at work in the human mind, namely, the confusion of the general with the particular. The average man is not a biologist and he only hears of bacteria in connection with disease, hence he, consciously or unconsciously, labels all bacteria as disease-producers. One sees the same process at work when the misanthrope gives up faith in mankind after painful experiences with a few bad types.

The particular group called bacteria exhibit characters that definitely assign them to the vegetable kingdom. This is shown by their general structure, their methods of reproduction, and the manner in which they assimilate their food. In fact, biologists are compelled to assign to them a place in that great family of plants which are comprised under the term Fungi. The bacteria have thus been placed on the shelf in a cupboard which is labelled Fungi. On the neighbouring shelves, but in the same cupboard, are found the moulds, those organisms that attack cheese, jam, and other foods; the Mushrooms and Toadstools that refresh or poison us; the Mildews that destroy our plants, and many others.

Iron Waters.

The "ordinary" bacteria, that is, those that may unequivocally be assigned to the bacteria, are of three kinds, distinguished by their shape. Some are rod-shaped, and all of this shape are placed in the genus *Bacillus*. Others are spherical in form (coccus), whilst a third group take the spiral shape (spirillum).

The iron-bacteria, as the name implies, are included among the bacteria, but they have been put in under protest as it were. They cannot be put under any one of the three classes that we have just mentioned, for they differ in shape, in habits, and in methods of reproduction. They even differ considerably amongst themselves. And yet there appears to be nowhere else to place them. The fact is that they have been banded together in virtue of a similarity in a certain kind of physiological activity. They live in what is called "iron-waters" that is, water containing a certain percentage of iron both in and out of solution. The insoluble part imparts to the water the well-known brownish-red colour which is characteristic of such waters. It is not so much the water itself that is coloured as the bed over which it lies, and the objects, like grass, etc., that are immersed in it. These take on a brownish-red colour owing to the deposition upon them of the insoluble higher oxide of iron. The water also contains a certain very small percentage of iron in solution, and it is by the oxidation of this soluble iron into the insoluble form that the colour is formed.

From the pathogenic standpoint such waters have no interest. Chalybeate waters are supposed to

exercise a tonic action on the system, and the bacteria that are swallowed at the drinking are no better or worse than the ordinary bacteria that are commonly found in drinking water. They are therefore in no way disease-organisms. In these iron-waters the bacteria usually live out a placid existence; and it would have been only the specialist that would have been interested in them, were it not that on occasions they suddenly manifest an extraordinary activity. It is the engineers that then quake in their shoes, for these iron-bacteria have the same devastating effect on their beloved water-reservoirs as a cloud-burst on an unprotected American town. The whole water-scape is changed in the course of a few days. Where formerly a complex of organisms lived amicably together in the water-reservoir, nicely adjusted and poised in a state of more or less stable equilibrium, there is now an upsetting of this state. One organism grows with an almost incredible energy, and there is a certain frenzy of reproduction that very soon changes the whole appearance of the reservoir. No longer can one look down into its depths and perceive objects lying at the bottom. It is now like a mill-pond, muddy-looking and red, dirty and dishevelled, if such a term can be applied to water. Small wonder the water-engineer looks troubled, for he is in charge and it is to him that the public looks for a clean water supply. When one examines such waters with the aid of a microscope one finds that the cause of the disturbance is one or more of the iron-bacteria. In this country we had a very notable case of an attack by iron-bacteria in Cheltenham in the year 1896. On the Continent there have been frequent visitations of this nature, and several commissions have from time to time been called into being to consider means for combating the sudden ravages of these fierce little plants. It therefore behoves us to keep a watchful eye on them even when they appear to be "doing nothing." The watchful policeman observes that a certain criminal, whose record he knows, appears to be behaving just like any ordinary citizen; but he keeps an eye on him all the same for he knows that things are not always what they seem, and that the man with an innocent face to-day may be the guilty criminal of to-morrow.

The best-known and certainly the most-dreaded of the iron-bacteria is one that goes by the name of *Crenothrix polyspora*. This organism may be found in small numbers in most of the reservoirs of this country It is known also to occupy the banks of certain rivers, e.g., the Clyde. It is not by any means a very abundant organism for at normal times it is very difficult to find. When it is found it will probably exhibit an appearance such as is shown in Fig. 1. The plant takes the form of a filament. There is a row of small rods enclosed in a sheath which, enveloping them rather closely, compels them to assume the linear arrangement. This sheath is open at the top, but is attached at its base to some particulate matter in the water. The whole filament is not very lengthy, as may be judged by the fact that the width is never more than two-thousandths to four-thousandths of a millimetre. A very elongated specimen might extend to a

FIG. 1.—CRENOTHRIX POLYPSPORA × 700
r, Bacillary rods enclosed in *s*, a closely enveloping sheath which projects from the end of the thread.

quarter of a millimetre. In Fig. 1 is shown a filament as it appears at normal times. The rods inside the sheath multiply by fission, elongation takes place with the result that the topmost rods are thrust out of the sheath. These come to rest, elongate, and in time grow up into a plant like their parents. The sheath is a somewhat accommodating structure, for the rods sometimes divide not only transversely to the direction of the filament, but also parallel to it. This results in a pressure being exercised on the sheath in an outward direction, consequently this structure is sometimes found in the form of a trumpet or cornucopia. This is shown in Fig. 2. The rods have divided up in three directions of space at the top and have become more spherical in form. It does not matter so far as the ultimate fate is concerned, for they are also thrust out from the top and develop in the same way as the rods. So much for the activities of this plant in the piping times of peace.

Matters assume a different complexion when a certain set of conditions holds. All the factors are not known with any degree of certainty, but the incidence of a Crenothrix "visitation" bears an analogical resemblance to the causes which determined the French Revolution. In the one as in the other the outbreaks were primarily the result of deep-seated causes which have operated for some time previous to the manifestation of the outbreak. Just as there was something radically wrong in the social fabric of the French Empire, with its autocratic kings and selfish nobles, so we may trace the Crenothrix epidemics to something that was radically wrong with the nature of the ground from which the water that flows into the reservoir was drained. Almost every reservoir contains in its flora some specimens of Crenothrix polyspora, but if the water has been drained from peaty ground, an inducement is given to this organism to multiply at an

inordinate rate. But Crenothrix may be present and the water may have been touched with peat without the occurrence, necessarily, of an outbreak. To these conditions must be added certain other factors of which we know very little at present—to wit, temperature, certain conditions of light, certain combinations in the flora and fauna of the water, and other factors of a more obscure nature. When all these

FIG. 2.—CRENOTHRIX POLYSPORA × 200.

Appearance of older filament in normal times.
s. Sheath.

pull together in a certain direction then the stage has been set which enables Crenothrix to perform its mountebank tricks. The sheath which encloses the cells (Figs. 1 and 2) is now unable to keep in the swarms that are formed by the repeated multiplication by fission of its enclosed cells. These not only swarm out from the top, but they break through the sheath laterally. When they emerge from the top the fragments of cells—for they are very tiny—are usually in groups enclosed in blobs of jelly, inside which they multiply. Those that emerge laterally form filaments, or they too may develop this jelly-like substance. The result is finally the same, namely, that the filament within twenty-four hours has given rise to hundreds of thousands, possibly millions, of tiny living fragments of cells. These apparently do not all form each a filament, although many do (Fig. 3). Instead, many go on fragmenting at a fast rate, with the result that in a short time—a week or two—the reservoir begins to resemble a horse-pond. If left alone the water will recover of its own accord. The very frenzy of its multiplication is the very cause of its undoing. In a few weeks the horde of fragments of Crenothrix so work on the constitution of the water that they make it unsuitable to live in. At any rate, the frenzied energy gradually dies down, the water gradually becomes clearer and slowly reverts to its normal condition, even although nothing has been done to it by the engineer to bring about this desirable condition. The fact is that the whole outbreak is inconsistent with the normal life of the reservoir and Nature has her own methods of restoring the balance. While it lasts, however, great discomfort may be caused to those who use the water, but there does not appear to be any change of a permanent nature that affects the water deleteriously.

The physiology of Crenothrix polyspora is interesting but has been misunderstood in the past. It is true that soluble iron salts are changed with greater rapidity into insoluble more highly oxidised salts as a result of the activity of Crenothrix polyspora. But it must be borne in mind that, sooner or later, this oxidation would take place in any case in the water, even although Crenothrix were absent altogether. Iron-streams do not always contain iron-bacteria. The change is obviously undesirable, and the iron-bacteria affect the situation by expediting the rate of oxidation.

It was formerly thought that the organism actually obtained the energy necessary to carry on the business of life by effecting this oxidation; now, however, we know that the centre of gravity for the nutrition of the iron-bacteria must be shifted from the iron to the organic matter in the water. We know now that the iron-bacteria feed on the organic matter, and that the process results in the iron which is combined with the organic matter being liberated from this combination. The liberation means also that it comes out of solution and that it is changed into the insoluble ferric hydroxide. The oxidation of the iron is thus an incidental matter. Physiologically the iron-bacteria

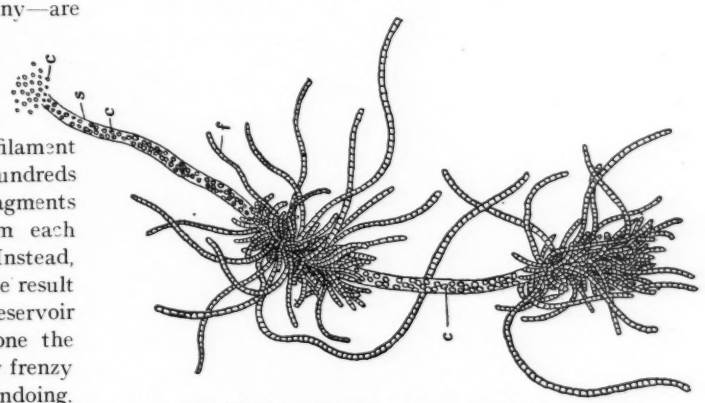


FIG. 3.—CRENOTHRIX POLYSPORA AT ITS PERIOD OF INTENSIVE MULTIPLICATION.

c. Cell fragments swarming from the top of the thread.
s. Sheath.
f. Filaments growing laterally from main thread.

are saprophytes in that they feed on dead organic matter. Whilst they are engaged in the process of taking in food they expedite a process which would take place in any case. It will be gathered from the statements that we made above that at normal times the number of individuals of Crenothrix is so small that the situation is not materially affected, one way or the other, by their presence. Crenothrix takes its place along with the other water plants and multiplies to a small degree only. Its saprophyte

nature is indicated by the fact that it has been cultivated artificially in media totally devoid of iron. It is not therefore an iron-organism in the sense that it is absolutely dependent on a supply of iron for the continuance of its existence.

Associated with Crenothrix in its "madness" is usually another organism of the same kind and known as Cladothrix polyspora. This is a more cosmopolitan organism and has a wider distribution than Crenothrix polyspora. It is as much associated with non-ferruginous, as it is with ferruginous, waters. Its claim to be regarded as an iron-organism rests on the same basis as that of Crenothrix. As a saprophyte it consumes dead organic matter. If this matter contain iron in its composition, this iron will be driven into the more highly oxidised and insoluble form. So far as the writer is aware it has never of its own accord been responsible for an iron pestilence; but often it has aided and abetted the crime of which Crenothrix was the leading spirit.

Recent Developments in Science.

A Review by J. Riley, B.Sc.

From time to time we shall publish a general view of developments in science, but it has not been found practicable to devote a set amount of space to the feature in every issue. Readers may however rest assured that all important advances will be treated in articles independent of these short reviews.

THE outstanding scientific event of recent months has, of course, been the meetings of the British Association for the Advancement of Science, which were held in Toronto from the 6th to the 13th of August. It would obviously be out of question to attempt to summarise the results of all the addresses and discussions in a brief page or two, and little would be gained from the effort. Fortunately, the British Association is so impressive in its mass-effect that, almost alone among the scientific happenings of the year, full publicity is given in the daily papers to the most important aspects of its proceedings. And for those who desire a complete account, the British Association has already published in full the addresses which were delivered by the Presidents of the thirteen sections, as well as the President of the meeting as a whole, under the title "The Advancement of Science, 1924." This should be read by everyone who wishes to keep pace with the general lines of scientific progress in its various branches.

Although we cannot hope to survey the whole field of subjects which were dealt with at the Conference, we can hardly ignore the meetings of so important a body. We propose, however, to limit our remarks to one or two of the more interesting details which various speakers referred to in the course of their addresses, particularly those details which refer to recent acquisitions of knowledge and which are of general interest. By so doing, we shall be able to give similar attention to other current matters of scientific interest.

The presidential address by Major-General Sir David Bruce, K.C.B., F.R.S., was on the very practical subject of "Prevention of Disease." Some of his most suggestive remarks concerned the undetermined group of infectious diseases—that very large class in which the parasite is either unknown or doubtful.

Invisible Germs.

This group is important because of the many familiar diseases which it includes, some of which are influenza, measles, scarlet fever and smallpox among human beings; as well as foot-and-mouth disease in cattle. The generally accepted explanation of the difficulty of ascertaining the cause of these diseases is that the living germs which are responsible are ultra-microscopic and therefore invisible—at any rate in some part of their life history. This belief is strengthened by the fact that many of them pass through porcelain filters, which are able to keep back the smallest visible bacteria. For this reason they are commonly known as "filter-passers."

Trench Fever.

An invisible germ can hardly be isolated and studied, nor can diseases in the undetermined group be dealt with by direct means. It is, therefore, a tribute to the ingenuity of medical research that so much success should have attended the devisal of indirect methods of preventing diseases of this class. One of the interesting examples which the President discussed from this point of view is that of "trench fever," which he regarded as one of the few "diseases of undetermined origin which are slowly emerging from the unknown into the known." The account which he gave is a striking example of what can be done by systematic and determined research into any

disease. In the early days of the war, trench fever was not even recognised to be a distinctive disease, and was confused with typhoid fever, malaria and even rheumatism. When it was observed to have characteristics of its own, attempts were commenced to track the disease to its source. The blood of trench-fever cases was found to be infective, but no germ could be revealed by the most careful microscopical examination of the blood corpuscles and lymph.

At length a Trench Fever Committee was formed and research organised, with the result that within six months sufficient was known about the disease to make its prevention a possibility. The germ still remained unknown, evidently because it is of the ultra-microscopic type, but the "germ carrier" was discovered, in the form of the body louse. This explains why trench fever disappeared with the end of the war and the elimination of the louse. Although the disease germ was not detected in the human body, however, the "infective agents" were actually discovered in the body of the parasite. These took the form of enormous numbers of very minute bodies—so minute, in fact, that their exact nature is still unknown, although they are regarded as either protozoa or bacteria, which develop in the louse, and pass on to their final stage in man.

Magnifying the Living Eye.

Of all the instruments which the science of physics has passed on to other sciences for their own particular uses, there is none which can approach the microscope in its extraordinary range of usefulness. The latest direction in which the assistance of the microscope has been enlisted was fully discussed at the annual meeting of the British Medical Association, which was held at Bradford on 22nd-25th July. This can briefly be called the "microscopy of the living eye." It is very clear that the examination of the eye would be much more detailed and thorough if it were possible to magnify it, and it is the magnification of the eye which the new method makes possible. Before it is observed, the eye must be illuminated, and this is effected by means of a narrow beam of light coming from a nitra slit lamp and condenser. The eye is then examined obliquely by means of what is called the "teleloup." This is really a pair of tiny opera-glasses which are mounted on a spectacle frame, and by means of it a stereoscopic image is obtained, double the size of the real object. The binocular microscope, which is a development of the "teleloup," gives a magnification of nine diameters or even more.

Already the new instrument has proved exceedingly useful. By means of it it is possible to determine the precise depth to which ulcerations have extended. The exact position and extent of inflammation of the cornea can also be clearly observed, while the detection and diagnosis of the various forms of cataract is a much simpler matter when the eye is magnified. It is hoped, too, that this ophthalmic microscope will render possible the detection of sympathetic ophthalmia at an early stage. In this disease it has been only too frequently the case that an unsound eye has only been removed when the sound eye has already been infected, and it is too late to save its sight. The first signs of danger are very tiny particles floating in the liquid in the interior of the eye. These can be seen with the microscope, whereas their detection by means of the naked eye is much more difficult. Finally, the investigation of the whole of the interior of the eye should now proceed to a much more detailed stage than was possible without the aid of the microscope.

Tropical Climate.

In his address to the Geography Section of the B.A., on the subject of "Inter-racial Problems and White Colonisation in the Tropics," Professor Gregory made some very interesting observations upon the connected subject of "Tropical Climate." It is a commonly held opinion that the climate of the tropics is unsuitable for settlement by white races. Professor Gregory, however, strongly disagrees with what he regards as merely a popular prejudice. It is preventable diseases and not an unsuitable climate that has given the tropics a bad name. Intense heat is not necessarily a dangerous factor, as is proved by the fact that the hot areas are frequently the healthiest. Thus Agra is both hotter and healthier than Bombay. The living body can accustom and adjust itself to temperatures much higher than any which occur in Nature. As Professor Gregory observes, "White men work in furnaces and bakeries at 600°F., and if they survive such temperatures even for short spells, they should be able to withstand the hottest climate on earth."

Moist heat is more trying than dry heat, and it is true that excessively moist heat would be insufferable by any man, white or black. A wet-bulb temperature higher than blood heat would undoubtedly be fatal. Experiment has shown that a man placed in a room in which the wet-bulb temperature was just above 98°F., fainted in forty minutes. But even in the tropics such wet-bulb temperatures are unknown. Moist heat is no more adverse to the white than to the black.

Other factors in climate are no doubt uncomfortable, but they do not prohibit colonisation by the white.

Thus the monotonous temperature of some tropical parts is undoubtedly relaxing, but such parts are few, and even in these cases "a change may be secured by a visit to some neighbouring hill country." Then, too, the sunshine of the tropics is supposed to be enfeebling, on account of the pernicious effect of the actinic or ultra-violet rays of the sun. Suitable clothing, however, can overcome this difficulty.

The Sub-Man.

In the current issue of *Science Progress* is given a full report of the recent Chadwick Lecture delivered by Professor E. W. MacBride, F.R.S., D.Sc., on the important subject of "Some Causes of a C3 Population." The chief topic discussed is the sub-man, whom we must contrast with Nietzsche's super-man. The sub-men form a very real C3 class in modern society, and their existence gives rise to a serious social problem.

The "sub-men" are what the American sociologists call the "morons"—mental defectives, but of a comparatively high grade, hence the danger to society. Such men are below the normal standard of mental development, and the importance of this point is indicated by the fact that the application of intelligence tests to delinquents in America has shown that a very large proportion of criminals, habitual drunkards and prostitutes are "morons."

Two chief points were considered in Professor MacBride's lecture. First of all, he showed that this mental defectiveness is hereditary. He then discussed the original causes of mental defect. His conclusion is that it is not due to "atavism" or a sudden "reversion" or "throw-back" to a more primitive human type. The appearance of a C3 class in the first place is regarded as due to germ weakening caused by unhealthy parental conditions. In support of this view, we are referred to some exceedingly interesting experiments by Gustav Tornier in connexion with goldfish. The Chinese goldfish is a "moron" or degenerate of the fish tribe. Its form and colouring were originally directly due to the insanitary conditions in which it was bred.

In the case of the human "moron," the unhealthy state and low vitality of the mother result in the weakening of the germ and developing embryo. This causes the resultant offspring to be stunted and dwarfed, both physically and mentally. In view of the fact that the low-grade character is hereditary, the conclusion of the lecture is naturally eugenical. "Is it not self-evident that if we eliminate natural selection—Nature's broom, by means of which she keeps other types of life healthy and clean—we must replace it by an equally efficient broom of our own? Until we do so I feel sure that we shall be continually encumbered by the problem of a C3 population."

Pure and Applied Science.

The Scottish Cattle Breeding Conference which took place at Edinburgh in July was interesting in more ways than one. The chief interest was centred in the fact that on its platform stock-breeders and scientists sat side by side, in an endeavour to be mutually helpful to one another. The breeder brought his practical problems, while the geneticist brought his theories born of laboratory experiment. The technical terms of the science of genetics are as yet unfamiliar to the average raiser of stock, and the empirical thinking of the stockbreeder must still be rather irritating to the theorist with his clean-cut theoretical ideas. But each has much to teach the other, and it is a healthy sign when any science sets out to be useful as well as instructive.

There will never be any lack of ardent spirits who love science for its own sake and who delight in the advance of scientific knowledge without any thought of its practical utility. The advancement of science is mainly due to the disinterested efforts of such workers as these. But to the majority of men, it is the power that such knowledge gives that is most highly esteemed. And it is a characteristic of the present day that all the sciences are turning to render what help they can in regard to the everyday problems of life. Every science just now is showing its willingness to assist the man who is primarily concerned with doing things in the world, and who can hardly fail to profit from the light which sound scientific theory is able to throw upon his problems and his work.

Mendelian Characters in Cattle.

One of the chief papers at this Conference, by Dr. Wriedt of Christiania, dealt with the inheritance of abnormal characteristics in live stock. Such abnormalities as certain kinds of blindness and deafness; and the liability to give birth to deformed calves or lambs, are already known to be Mendelian characters, which are inherited according to laws which are perfectly familiar to the scientist. A recognition of the laws of heredity will direct the attention of the stock-breeder to such Mendelian characters, and will show him how to breed in order to remove them from his stock.

A further interesting paper, by Professor Cole, discussed the problem of inbreeding, and could hardly have failed to clear up the diverse opinions that are held upon this method of improving the character of a herd. Inbreeding is only completely successful

when there are few undesirable recessive characters in the members of the herd, which are bound to appear when the practice of inbreeding is resorted to. It is quite true that these degenerate qualities can be removed by a process of weeding out the individuals which develop them. There is a danger, however, that ultimately it may be necessary to weed out the whole flock or herd in this way, and that nothing may be left.

The Smoke Problem.

Since the days when the shortage of timber for fuel gave rise to the first experiments in the use of coal for domestic purposes, there has been no period during which those who live in towns and cities have ceased to consider ways and means of overcoming the smoke nuisance. As an illustration of the assistance which science can render in this connexion, we may refer to the paper which Dr. J. S. Owens read before the Mathematics and Physics Section of the B.A. The title of the paper was "The Automatic Measurement of Atmospheric Pollution," and it consisted mainly of a description of a new and simple method of measuring the "smokiness" of the air, together with an account of some of the results obtained by the use of the method.

The degree to which the atmosphere is polluted is usually estimated by means of what is called the "jet dust-counter method." The air which is to be examined is first slightly compressed and saturated with moisture by means of a special damping chamber. It is then blown as a ribbon-shaped jet upon the cover glass of a microscope. The fact that the pressure to which it has been subjected is suddenly released causes the air to expand to its original volume. As it expands, it cools and is no longer able to hold all its moisture. The excess moisture is "squeezed out," and condenses as a mist which settles round the particles of dust which the air contains. They are thus in a damp state, and when they strike the cover glass they stick to it, and remain there even after the water has evaporated.

In order to estimate the smokiness of the air it is then necessary, by means of the microscope, to count the particles and to estimate their size. It will be realised that this method can be trusted to give very accurate results and, further, that the microscopic examination can be employed to obtain very detailed information as to the size, shape, colour and general character of the smoke and impurity particles.

An Automatic Method.

It is not, of course, possible to count the particles automatically, although a comparison of the two methods will enable us to express the results of the automatic method in terms of those of the counting method. The automatic recorder is a white filter paper, through a small area of which the air is steadily drawn for a fixed period. The air passes right through, leaving the particles of dust deposited on the paper. This causes a discoloration and gives the paper a definite grey tint. By comparing this with a standard scale of shades, the extent to which the air is polluted can be "read off" with remarkable ease. The result so obtained is very accurate. Its only weakness would arise in the case of an atmosphere in which the dust particles were light in colour. For smoky atmospheres in which the dust is black, the results are very satisfactory.

The automatic method has been used to compare the variations in the amount of suspended impurity in the air from hour to hour during the day. As a general rule, in the case of an industrial city, the smokiness of the atmosphere begins to increase about four or five every morning and rises to a maximum by nine or ten o'clock. It then falls slightly, but rises to a second maximum an hour or two later. It is considered that the double maximum is due to the fact that there is a double source of smoke particles. The first maximum is due to industrial smoke, and the second to domestic smoke. The comparison of the smoke given out on weekdays with that on Sundays shows that, in the case of Blackburn, domestic smoke is nearly twice as much as that from factory chimneys. The actual ratio is 1.85 to 1.

Human Radiators.

It is now generally recognised that the cooling power of the air in which we live and work is a factor that affects our health as well as our bodily comfort. The body is continually producing heat by the combustion of the tissues which accompanies every kind of exertion, and this heat must be got rid of as quickly as it is produced, if the bodily temperature is to be maintained at a constant level. This loss of heat takes place chiefly at the surface of the body, which acts as a radiator which passes the heat of the body to the air which comes into contact with it. The human radiating system is a very wonderful contrivance. For one thing, if the loss of heat is greater than the body can stand, the supply of blood to the surface blood-vessels, which form the most exposed tubes of the human radiator, is cut off and the blood flows mainly below the surface. Under these circumstances, the outer layer of bodily tissue acts as a "lagging" which cuts the radiated heat down to a more reasonable quantity. If discomfort is still felt, we ourselves

may reinforce the natural "lagging" by putting on extra warm clothing.

On the other hand, if the body shows the slightest degree of over-heat, the skin becomes flushed on account of the opening out of the surface blood-vessels to the blood which needs to be cooled. This comes to the surface of the body and is given every chance of losing heat. If this means is still insufficient, the body perspires, and still further cooling is brought about as the sweat evaporates.

The Cooling Power of Air.

In the issue of *Nature* for 16th August there appeared an interesting paper by Leonard Hill, F.R.S., which dealt with the effect which the condition of the atmosphere has upon the cooling of the body in certain familiar cases. The paper was entitled "The Cooling Power of the Air in Trains, Trams and Buses." This was measured by means of the "Kata-thermometer"—a special kind of thermometer with a large bulb, "roughly the size of the end joint of the thumb." In consequence, the Kata-thermometer is extremely slow in registering changes of temperature. The method of use consists, first of all, in heating the thermometer to well above the bodily temperature, and then noting the time taken for its temperature to fall from 100° to 95° F., a range of temperature which is round about that of the body under normal conditions of health.

If the cooling powers of the air are good, the time taken for this drop in temperature will be relatively small. If the air is deficient in cooling power, the time taken will be considerable. It will be seen, in fact, that the cooling power of the air (which is the same thing as the rate at which the bulb of the Kata-thermometer loses heat) will be inversely proportional to the time taken for the temperature of the thermometer to fall through a fixed range. The thermometer is carefully graduated by finding the number of seconds taken for the temperature to fall from 100° to 95° F., when the bulb is losing 6 millicalories of heat per sq. cm. of surface per second. This corresponds to what is called a "cooling power of 6." Knowing the time which corresponds to this figure, it is a simple matter to calculate any other cooling powers corresponding to other times.

Standard Cooling Power.

The "standard cooling power suitable for sedentary work in ordinary clothing is 6." In a stuffy room, the figure is 4 or even less, while a cooling power of 8 indicates a room rather too cold to be comfortable. "Out of doors, when the wind blows, cooling powers are higher; for example, 10 on a genial summer day, 20 on mild winter days, 40 on cold winter days."

In the case of trains, trams and buses, the cooling powers are usually much higher than 6, a fact which is partly due to the temperature of the outside air, but much more to the fact that the air is in motion. The importance of movement of air in securing cooling power is shown by the fact that "tubes and steam trains with closed windows and trams are relatively stuffy places (cooling powers 4-10), compared to the outside of buses (cooling powers 10-31), and steam trains with windows open (cooling powers 9-19)." It is interesting to note that, while the cooling power in a moving train on the Hampstead tube was only 5-9, the cooling power on the platform was 7-16. In the latter case, however, the velocity of the air was double what it was inside the train.

The whole paper had an eye to health as well as information. It was pointed out that "catarrhal infections are spread by wrong conditions of the atmosphere indoors, and by repeated massive doses of microbes inhaled from 'carriers' who sneeze and cough in close crowded places." Massive infection of this kind is impossible when the air we breathe is kept in motion by a constant stream of fresh moving air. This condition operates on the outside of buses and in trains with the windows open.

Books Received.

Handbook of the British Flora. GEORGE BENTHAM, F.R.S., and SIR J. D. HOOKER, C.B., G.C.S.I., F.R.S. Seventh edition, revised by A. B. RENDLE, M.A., D.Sc., F.R.S. (L. Reeve & Co. Ltd. 12*s.* net).

Tantalus, or the Future of Man. F. C. S. SCHILLER, M.A., D.Sc. (Kegan Paul. 2*s.* 6*d.* net).

Elements of Rural Economics. THOMAS NIXON CARVER. (Ginn & Co. 7*s.* net).

The New Agriculture. HENRY JACKSON WATERS. (Ginn & Co. 7*s.* 6*d.* net).

Psychology and the Sciences. Edited by WILLIAM BROWN, M.D., D.Sc., M.R.C.P. (A. & C. Black Ltd. 7*s.* 6*d.* net).

The Chemical Age Dictionary of Chemical Terms. (Ernest Benn Ltd. 16*s.* net).

The Passing of the Phantoms. C. J. PATTEN, M.A., M.D., Sc.D., F.R.A.I. (Kegan Paul. 2*s.* 6*d.* net).

General Science. Vol. II. G. H. J. ADLAM, M.A., B.Sc., and O. H. LATTER, M.A. (John Murray. 3*s.* 6*d.*).

Combustion in the Gas Producer and the Blast Furnace: A New Theory. IR. DR. A. KOREVAAR. (Crosby, Lockwood & Son. 15*s.* net).

Space Time Motion. PROF. A. V. VASILIEV. (Chatto & Windus. 7*s.* net).

A Neglected Complex and its Relation to Freudian Psychology W. R. BOUSFIELD, K.C., F.R.S. (Kegan Paul. 4*s.* 6*d.* net).

The Transpiration Stream. HENRY H. DIXON, D.Sc., F.R.S. (University of London Press. 2*s.* 6*d.* net).

The Great Dew Pond Myth.

By Eric W. Walford.

There is quite a respectable tradition of mystery attached to so-called dew ponds. In point of fact there is no real mystery. Scientific investigation has been applied to the problem and another myth has been exploded.

THERE are certain ponds situated on the tops of hills, generally in the south of England, which go under the name of " dew ponds," and very widespread is the idea that by some mysterious means they automatically keep themselves filled by absorbing dew. This notion is quite wrong, and therefore the ponds in question are misnamed, but the name is likely to stick, and the fallacy as regards their operation to survive for many years. Fallacies are very hard to kill, particularly where they are based upon something of a mystery, and there has been enough nonsense talked and written about the operation of these ponds to establish the mystery with some thoroughness.

A DEW POND ON THE CHALK DOWNS OF HERTFORDSHIRE.

It should be noted that the ponds are always on the hilltops, but why this is so, if they function by dew collection, is not clear, as dew is deposited in valleys also. They are very shallow and of large area, generally merely saucer-shaped depressions in the chalk, and are used for supplying grazing cattle with water. This very large area constitutes a big catchment surface, so that they are well fitted for catching and storing rain or any deposited moisture, and there is no doubt but that a very large part of their success is due to this very large catchment area.

By some it is stated (but it is ridiculous to suppose there can be any authority for this) that the original art of making these dew ponds goes back to the Neolithic era of man, say, four to ten thousand years ago, and that he relied upon dew-collecting ponds for the water supply necessary in his hilltop fortresses and camps. The best archaeological authorities discount any connexion between the so-called " dew ponds " and the adjacent earthworks. However, some people like to think that the art of making and repairing these dew ponds has been handed down from father to son for some five thousand years !

The explanation in support of the dew deposition theory is that the builders of the ponds take careful steps to prevent heat being conducted from the earth to the pond. For this purpose they make a shallow basin in the chalk, then spread a thick layer of straw, or some other non-conductor of heat, and finally the puddling clay on top of this. They ignore the fact that the straw rots and becomes useless as a non-conductor of heat during the first winter. They also like to baptize the pond with snow, and it is generally considered that, if the bottom of the pond is given a nice cool bath to start with, it will keep cool during the hot summer, or a succession thereof !

In 1911 the Royal Society instructed Mr. E. A. Martin, F.G.S., to proceed to the South Downs and investigate these mysterious ponds, and his findings should once and for all kill the idea that dew is at all responsible for the maintenance of the water.

On investigation, Mr. Martin found that, of the so-called dew ponds which " never run dry in the hottest summer " (according to the testimony of the oldest inhabitant, etc., etc.), nearly all of them failed to hold water throughout the dry summer of 1911. A few, however, were successful, and were used for watering cattle, so that, taking into consideration also the daily evaporation, the loss of water was considerable. In these few ponds the level only slightly fell throughout the summer, showing that water was being received into the ponds. This can only come from three sources (ignoring springs) :—

(1) rain ;
(2) dew ;
(3) some hitherto unascertained source.

There was no rain, and therefore the cause lay elsewhere.

Now dew, which, of course, is the moisture in the air, is only deposited on something on the earth's surface which is cold—that is to say, below the dew point. On a hot summer's night dew undoubtedly is deposited, as we all know, but, unfortunately, the worst surface to receive dew is that of water, for the simple reason that in water the hottest portion always rises and

DIAGRAM OF A SO-CALLED DEW POND.

The black line represents the cement or clay puddling which is sometimes protected from damage by cattle with a covering layer of chalk. The arrows indicate the direction of the usual prevailing wind. Note the bushes frequently planted at the side.

forms the surface, and on a hot summer's night there is insufficient time for this *hot* surface to fall below the dew point, and no dew can be deposited. This is a scientific fact which is incontestable, and was carefully checked by Mr. Martin in his experiments, wherein he used a large number of recording and other thermometers to ascertain the ground, water and air temperatures during the night.

A second definite fact against the dew theory is that the maximum dewfall recorded anywhere in England is totally insufficient to make up for the water lost by cattle consumption and evaporation. The maximum dewfall is only from 1 to 1½ inches per annum, whilst almost that quantity per night is necessary if the loss during the day is to be made up by dewfall.

Yet a few of these ponds kept going.

It is not until one stays all night by one of these ponds, and that under the right conditions, that the explanation is found, namely that the water comes from the early morning mists or clouds.

As stated, these ponds are always on the hilltops, and close to the sea. I have heard of others inland, but not having examined them I am not convinced that they do not get their supplies from springs in cases where they keep going through a hot summer.

During the chilly early morning hours after a hot summer's night, sea mists roll up over the hills and saturate their tops but not the valleys, depositing in the hilltop ponds considerably more water than can ever be obtained by dewfall. Furthermore, this deposition and collection is very largely assisted by the surrounding vegetation, and particularly by trees and shrubs which are often arranged on the side of the pond next the coast. The result is that these overhanging shrubs collect moisture from the mists, or clouds, which drops continuously into the pond.

From this it is clear why these self-filling ponds are not to be found in valleys, and it also explains why downland grass near the coast keeps in such a wonderful condition throughout the dryest of summers.

Mr. Martin was able to find a proof that sea mists were responsible for the supply, by testing the ponds for salinity. Sea mist is evaporated sea-water, and by mechanical action a slight amount of salt would be expected to be taken up with the moisture Appropriately, it was found that the ponds nearest the coast had a higher salt content than those more remote.

It has been mentioned above that it is not to be expected that dew would be deposited upon water. If a dew collector is desired, an efficient one can be very simply constructed and some interesting experiments carried out. It is merely necessary to arrange a sheet of corrugated iron at an angle of forty-five degrees and clear of the ground. It must be supported by devices which are non-conductors of heat: for example, by wooden pillars at four corners; or it can be suspended by strings from the corners, which is probably the simplest arrangement. Directly the sun has set, the temperature of the corrugated iron will fall below the dew point, and moisture will be deposited upon it, eventually draining off into a trough arranged underneath. This arrangement has the advantage that it will also collect the rising dew. For the most part dew is deposited from above downwards, but a certain proportion rises from the ground. The latter, therefore, settles on the underside of the corrugated iron, and the former above.

If any reader is interested in collecting and measuring dewfall, he can, in this way, ensure that he is getting efficient results with simple apparatus.

A NEW COCAINE.

It is reported that another cocaine substitute has recently been added to our already formidable list by the well-known German chemical firm of Merck at Darmstadt. This latest addition is claimed to be totally devoid of any "habit-forming" properties. Upon the most important property, apart from its anaesthetic action, we are not informed, however. The ideal cocaine substitute, from the surgical point of view, is one that combines an equal anaesthetic action with a total absence of any adverse after-effects. The two most successful substitutes synthesised up to this last are novocaine and B-eucaine; of these the former is much less toxic but has also a less powerful anaesthetic value than the latter; used in conjunction with adrenaline, however, it has been found greatly superior to cocaine. If the new cocaine should supplant either of these we shall be one step further on the road to the ideal local anaesthetic.

The Reported Transmutation of Mercury into Gold.

Widespread interest has been evoked by the claims of German scientists. If their facts are correct the mechanism of at mic change so discovered may be very important in its application to other problems.

THE transmutation of mercury into gold appears to have been achieved at last by Professor Adolf Miethe and Doctor Stammreich of the Charlottenburg Technical College, Berlin. There have been rumours about the successful progress of the experiment for some time, but it is only in the last few weeks that the scientists concerned were able to make a definite statement, as there was always a possibility that the gold found in the earlier researches was an accidental impurity.

They now claim to have eliminated all potential sources of error and will shortly publish full details of the process. The complete acceptance of their claim must be deferred until other scientists have had the opportunity of repeating the experiment, and confirming the claims advanced.

The history of this discovery is in its way ironical. For centuries man has sought an elixir which would transmute base metal into noble. The old alchemists came staggeringly close to the verities of modern science when they claimed that mercury and lead were elements which could be transmuted into gold. And to-day this feat has been accomplished, not of set purpose, but arising out of an accident.

The Discovery.

Professor Miethe had been experimenting on the effect of ultra-violet ray action on glass and minerals used in optical work. A Jaenicke mercury vapour lamp of the latest type built of quartz glass and having the modern type of burner vented to the atmosphere was employed, and when used with too high a current developed a trick not uncommon with these lamps—it "blackened" just as wireless valves will, and deposited a material of some kind on its walls. As the purpose of these lamps is to afford an intense source of light this blackening was a serious defect.

The manufacturer could not account for it, so the two scientists set to work to analyse the deposit in the hope of tracing the error to a faulty component. They suspected some minute impurity in the mercury. On analysis of the deposit they found a material though minute proportion of gold.

From this accidental discovery they set to work to prove that in such an apparatus most carefully constructed of picked and rigorously analysed materials without a trace of gold, gold would be deposited from the mercury vapour.

The process is not likely to be economically profitable, for the amount of gold recovered only amounts to less than the tenth of a milligram, while this has only been made by running the lamp at a high current pressure and consumption for several hundred hours. It appears probable that the process is purely dependent on a certain critical voltage being employed, mere excess of voltage alone being unable to effect the transmutation. In the past far higher sources of energy have been applied in the endeavour to break down atoms, and in Professor Rutherford's experiments on gases bombardment with α particles was used. The collapse of the mercury atom apparently takes place at the comparatively low pressure of 170 volts, but the time occupied to produce a minute quantity of gold is considerable. Two hundred hours and a consumption of 2,000 watts was necessary to produce 0.1 milligram of gold.

Delicate Tests.

The methods of analysis necessary to isolate this quantity from the deposit were necessarily delicate. The deposit was first cleaned of mercury by treatment with nitric acid, and the residue dissolved in aqua-regia answered all tests for gold, including the exceptionally delicate Purple-of-Cassius test which will indicate one part of gold in ten millions. In the end an actual trace of metallic gold was isolated, but the amounts so collected to date have not been sufficient to permit of its atomic weight to be determined in order to find out whether it is the same as natural gold, or an isotope varying from it in the same way that radium lead differs slightly from natural lead.

The exact detail of the experiment is awaited with considerable interest and it will doubtless be demonstrated in Britain when particulars are available.

The speculative mind will be intrigued by two possibilities. Firstly, this process may, though it seems improbable, lead to a more economical method of breaking down the mercury vapour; secondly, it leads us to wonder whether the old alchemists ever did succeed in making gold from mercury by some empirical chemical process.

Raymond Lully is credited with having made gold for Edward III of England and his *Ars Magna* contains a good deal of sound practical chemistry which was materially useful to his successors. Cynical moderns have suggested that Lully's utility to the king was

more likely to have been a skilful and not easily detectable method of adulterating the coinage.

Be that as it may, the legend that gold can be made from mercury is now scientifically confirmed, and once again an age-old dream has come true.

PROFESSOR MIETHE
of the Charlottenburg Technical College.
[*Photo, Dorien Leigh Ltd.*

Now let us turn to the interpretation of the facts by a scientist. We refer the facts as stated to Doctor A. S. Russell, B.Sc., Scientific Adviser to DISCOVERY, and ask him, "Is this transmutation possible or probable?" His answer follows:

"A student of physics on being told this and asked to venture an opinion upon it would be in a quandary. He knows that transmutation occurs spontaneously in Nature among the heaviest elements, and that it ought to be effected artificially unless present views of atomic structure are radically wrong. But he is aware how often in the last twenty-five years extravagant claims of transmutation have been confidently made—not merely by cranks or nobodies—and how small a part of these have stood the scrutiny of test and time. It is now known that transmutation may be effected in one general way only, and that is by changing a part of the atom called the nucleus. This change may be brought about by one or two agents only. Great heat or tremendous pressure might be considered obvious agents, but they are not; no change of temperature or of pressure yet tried has brought about transmutation. The agents that are possible will be better understood when we consider what the nucleus is. The nucleus of any atom is a very tiny part of it near its centre, which contains almost the whole of the weight of the atom, and is composed exclusively of positive and of negative charges of electricity. It contains, however, more positive charges than negative, so that on balance it appears to consist of positive electricity only, since one positive charge neutralises exactly one negative. The amount of this excess on the nucleus of an atom is the most characteristic property of an element. Every atom of platinum, for instance, has an excess of 78 positive charges of electricity on its nucleus, gold has 79, mercury 80, lead 82, and so on. Each element in Nature has one number of this kind, and each number refers exclusively to it. It follows as a consequence that one element may be changed into another as soon, and as easily, as the excess positive charge on its nucleus may be altered. Whether the alteration be great or small matters not. *Any* alteration brings about transmutation.

Nucleus Changes.

Granted this, and given that there are but two kinds of electric charges, positive and negative, there may be four ways in which an alteration of the nucleus may be effected. The charge may be decreased by expelling positive charges, increased by expelling negative charges, decreased by adding negative charges, and increased by adding positive charges. This statement is easily made, the great difficulty is to carry out any part of it. But difficulties have not been insuperable. Thanks to the genius of Sir Ernest Rutherford, Professor Soddy, and their co-workers, it is now known that the two first of these ways are those in which transmutation occurs spontaneously, but uncontrolled by man, among the very heaviest of the elements. The cause of this spontaneous expulsion of positive or of negative charges is still a mystery. Something occurs in the nucleus which leads to a "flare-up" and the ejection of part of its contents, but the cause of this is still obscure. If it were known it might be possible for workers in this field to imitate the natural process and bring about at will the transmutation of the heavy elements, but, as said before, this they have not yet accomplished. Theory indeed tells them that none of the methods yet tried could be successful.

There are, however, still two of the ways mentioned to be considered. Neither of these are believed to occur in Nature, at least upon the earth, but there is no *a priori* reason why they should not be made effec-

tual by man. One of these, the third of those given above, appears the most likely way of explaining Dr. Miethe's experiments. Dr. Miethe started with the heavy element mercury and produced gold. The former element has an excess of 80 positive charges on its nucleus, the latter has 79. A single negative charge, in consequence, if successfully conveyed to and absorbed by the nucleus of a mercury atom, would transform it into gold. Now this was possible in his experiments. The high-tension electric discharge which he used contains swiftly-moving negative charges of electricity. In his apparatus these would collide with atoms of mercury. A small proportion of the charges would succeed in penetrating the outer layers of the atoms and of making straight for the nucleus. The majority of them would not do this, partly because, being fired at random, they would miss the very small target, the nucleus, and partly because the necessary energy to reach the nucleus would be lost in encountering obstacles inside the atom. But once the negative charge had penetrated all protecting barriers, it would fall into the nucleus, because, as is well known, positive charges attract negative ones. The moment the charge is captured by a nucleus of mercury that nucleus becomes a nucleus of gold.

It is obvious that if this explanation be a possible one the quicker the negative charges may be made to move in the electric discharge the more mercury nuclei will be converted into gold nuclei, and this Dr. Miethe appears to find. In work of this kind which consists, in essence, in firing a negative projectile through barriers at a target (the nucleus), there is no method available of aiming accurately or of correcting fire. With the electric discharge one is blazing away as hard as possible in all directions in the hope that some of the projectiles may hit the mark. It was doubted, until Dr. Miethe's experiments were published, whether any could hit at all, or, if some did, if there were sufficient hits to produce in a reasonable time an amount of another element that could be detected by chemical tests. Dr. Miethe, in affirming that there is, has opened up interesting and important possibilities.

An Alchemist in the Pamirs.

By Afghani.

This article arrived by registered letter from the East and was written before the news of Professor Miethe's experiments had been published. The nom-de-plume "Afghani" conceals the identity of a well-known and reliable Oriental scholar and observer. From a Western point of view the Eastern alchemist's ideas of chemistry are pure Alice in Wonderland—but the article is interesting for its description of an alchemist of to-day and the system of thought which inspires his odd researches. His conversion of lead to silver may have been an interesting piece of sleight-of-hand or more probably a simple adulteration of the lead by adding some metallic salt which would produce a hard alloy with the appearance of silver.

TRAVELLING through the valleys of upper Kashmer for weeks, we were picking up our way handicapped by dense white mist. Constantly we halted to gather various members of our party, and after refreshing ourselves as best as we could with the hot contents of our flasks, we journeyed on and on, as if blindfolded, because one could have cut the mist with a knife, it was at times so thick. Gradually, the mist began to be lifted up, it disappeared slowly, the clouds lighted up one by one in all the colours of the rainbow. They separated and showed patches of clear blue sky and dazzled our sight by colours of white snow, until the whole panorama cleared up, and we again saw the wall of snowy ridges crowned by immensely lofty summits. There were here and there scooped places in between the ridges and when the sun shone it lit them up and presented an extraordinary sight resembling huge witch-pots all ablaze.

We stood for a while motionless, awe-stricken and chained to the spot as if by magic, till I was startled by a rude knock on my shoulder. Looking back, I was at once appalled and surprised that the person who had struck me neither belonged to our party nor, indeed, did he look like a human being of the twentieth century. He wore a sheep-skin coat, tied with a rope at the waist, had long felt shoes, and wore a conical fur cap, very much after the fashion of Tabriz Darwashes. The hair of his head fell in tresses over his shoulders, and his beard was long and unkempt. The growth of hair on his face was so great that one might have to remove the growth to have a peep at the face. It was, then, this creature who had struck me with his staff, and asked me in Bokharian language as to whether I had any very hot tea that he might drink. For a minute or two many things flashed through my mind. I thought of the grandeur of the scene,

of that great vastness; the absence of any indication of human beings; of those gigantic glaciers; and then back to the man beside me, who might have sprung up out of that misty whiteness with his strange dress and his unlooked-for speech. Opening the flask, I gave it him; he immediately applied it to his lips, and drank the hot tea with an audible indication of relish. "Oh! this is like the Bokhara tea," he said, and, thus satisfied, he told me of his journey from Bokhara, his home, thither in search of herbs for the sake of alchemy. "Do you make gold out of the baser metals?" I asked in excitement, scenting a great discovery—to which he replied by burying his hand deeply in an inside pocket from which he produced a fairly large piece of solid unalloyed gold which his alchemic art, he declared, had evolved.

Of course, as we know, the alchemic art is as old as the ancient history of the world itself, and an alchemist cannot in ordinary cases be made to discuss what he knows of his mysterious cult; also that they, as a rule, shun human companionship; but this new acquaintance of mine, feeling the want of human intercourse, acceded to my request and took the benefit of what little comfort we had in our camp.

A Demonstration.

When we had partaken of our meagre food, which consisted of goat's flesh, and sat down before a huge fire, the alchemist became communicative and told me that he had been a wanderer for pretty nearly thirty years, and had the cult of alchemy at heart since his boyhood. He had journeyed far and wide in quest of herbs, the addition of which, he stated, transmuted the lead into silver and copper into gold. The usual question which one puts to such professors is whether they have been successful, and whether they would show the manifestations of their art to others. The "Mohawis"—alchemist—looked hard at me, and with a stern voice of a real fakir promised to show us a few arts of his craft, for which he had travelled to the four corners of old Asia. "Produce some lead," he commanded, "and here and now you will see the silver made—real silver!" But we had no metal as such, except a small snuff-box of my friend Mohamed Yusuf, and Yusuf would much rather part with his head than with his box, for the snuff would lose its pungency without the box. It was therefore no easy matter to persuade Mohamed Yusuf to give up the box. This was melted, and the alchemist, producing a white powder from his pouch, he threw it on the melted lead. That seemed to have "cleaned" the metal, as black impurities collected round about the melted lead in the receptacle. After that he took out a yellowish powder, and throwing a pinch of it on to the metal he covered it quickly with a bowl, and asked us to wait till it became cool. Those minutes, though not more than ten or fifteen, seemed to us in our excitement as many years, till he rose and lifted the cup. There in the receptacle was a metal completely changed. It proved to be silver. One can well imagine the desire of each and every one of us to learn the art from him. A change now overcame his communicative attitude towards us, for he not only desired a change of topic, but on our pressing him to divulge the secret he became positively abusive for the curiosity that we showed about his affairs. I thought it best to let the matter drop for that evening.

Arsenic Poisoning.

For the next fortnight or so I had the alchemist as my "chief man," and while we shikareed and took scientific observations, he did nothing but lose himself amongst the glens and return at dusk, bringing herbs of various kinds, the chemical properties of which he tested at night. One fine morning I was surprised to hear that the alchemist had been very ill the whole night. He complained of abdominal pains, and when I went to see him I found him suffering from acute arsenical poisoning. The usual form of relief was employed, and it was late in the afternoon when it could be said with certainty that he would live. We had to call a halt of eight days on his account, and during that time the alchemist showed himself quite willing to discuss the secrets of alchemic art with me, then only when I was alone. I asked him point-blank whether he would teach me his craft, to which, despite my attending him for so long in his illness, he bluntly replied that it had taken him forty years to learn what I asked him to teach me in as many hours. Here he related a story of how he was imprisoned by the Khan of Bokhara for refusing to teach him the art. But I was determined to learn something, in any case, of what he knew; the following, therefore, I was able to gather while we talked on the march in that highway of the Pamirs. I give it as I received it.

The alchemists contend that it is possible to transmute a baser metal into a precious one, because the nature of both of them is the same. To say that all metals are "single," each possessing its particular "unity," and that such units cannot be produced by mixing other two or three or more single units, is false. It is also said that different metals have different weights, and that when a mixture of metals is put to electrolysis its parts disintegrate, while gold and silver do not, which shows that they are of one atom, and cannot be produced artificially by the mixture of other metals; also that artificial gold and silver, if at all

possible of being evolved, would lack the weight and consistency of the natural gold and silver.

Further, that almost all metals have taken their shapes through the agency of mercury and sulphur. It is due to the action of heat on these two substances which has produced various ores or metals. In the natural production of gold, for instance, the two elements of mercury and sulphur have joined each other in right proportion, in "pure form," and the heat which was necessary to "mix" them was "just right." Perfect conditions of everything was obtained, and gold was produced. But in the production of silver—a less precious metal—all perfect conditions were not obtainable. In the process of silver production the sulphur had less colouring matter in it—for sulphur only colours; mercury was less in quantity and the necessary heat was not supplied, the result was silver. From this it can be deduced that all metals have a common origin, and that all baser metals would reach their goal of being transmuted to gold if all the three above-mentioned conditions were provided in their "right proportion"—e.g., the pure mercury and sulphur and the correct degree of heat.

Alchemical Theory.

Now, as in Nature these precious metals are produced through the action of heat on mercury and sulphur, there is every reason for the belief that, acting on natural principles, man's knowledge might be employed to obtain natural results. In silver and gold mines we find not only silver and gold, but a host of others. The reason of the presence of different ores in one and the same mine is that heat was given to mercury and sulphur; varying degrees of heat reach different layers of mercury and sulphur deposits—some particles of sulphur and mercury are pure, others impure—and various forms of metals, precious and base, are formed. It is the same heat, the same sulphur and mercury, but it is due to impurities and variance in the heat that one observes the presence of so many different metals in a mine. The above makes it clear that one substance is capable of being transmuted into another, lead into silver, copper into gold; or that silver itself might be coloured to represent gold.

If one subjects mercury to heat, it evaporates and nothing is left in the pot, but with the addition of the juices of certain herbs it is possible to "cut the wings" of mercury, so that it will not disappear, no matter what degree of heat is given to it. That shows that the nature of the substance is changed. This chemical action on mercury is also performed for the reason that mercury might be made capable of being mixed with lead, so as to increase the weight of lead to that of silver. Silver is coloured in various ways—the chief chemical used is sulphur—but copper can also be employed. The two are melted, and are mixed in that condition. Silver is coloured, and then the alchemist's art contrives to remove the copper and yet retain the colour of the silver. This can be manipulated through continued heating and then painting certain chemicals on the metal.

Root Ideas.

The basic principle of all Eastern alchemic experiments is that almost all metals take their origin from mercury and sulphur, and that the heat of the sun "baking" these two substances transforms them into various ores. The perfect state of purity in the substance of mercury and sulphur, coupled with a right degree of heat, is necessary to produce gold. It is then the endeavour of the alchemist to "purify" that mercury and sulphur which one purchases from a druggist, and subject them to such a temperature that they might possess the power of transmuting the lead into silver and copper into gold. With this end in view, various herbs are sought, while assistance is also taken from other chemicals. There are two schools of Eastern chemical-experimentalists, the one who employ the herbs, they are called *Mushriqee*—the Easterners; the other, who call to their aid certain chemicals, and they are called *Mughrabi*—the Westerners. The employment of herbs is said to curtail the labour of "purification."

Certain experiments might last for two years or more, but when once successful it would mean "eternal wealth." Arsenic is not a few times used for this kind of purification, and "baked forms" of many chemicals are often employed. Substances are "baked" in various ways. Sometimes one has to rub the chemical with a juice of a particular herb for forty days before it is "fit" to be baked. When ready, the substance is put in a small earthen pot and coated with chalk, and then is placed in a heap of burning cow-dung cakes for forty-eight hours. At another time a metal might be baked by a chemical.

Many of these most interesting experiments were told to me by the alchemist, and he gave a "prescription" also, but it proved to be so tedious, and certain herbs so difficult to procure, that if I were to get the wealth of alchemy I should have to don the same clothing as he wore and roam about in great jungles in quest of herbs, and, after procuring them, two years' solid work were necessary to accomplish my task. That desisted me, and indeed might have desisted a good few others, and a good job too—otherwise we would all be alchemists and gold as cheap as copper, and the romance of alchemy would disappear.

The Excavations at Ur.

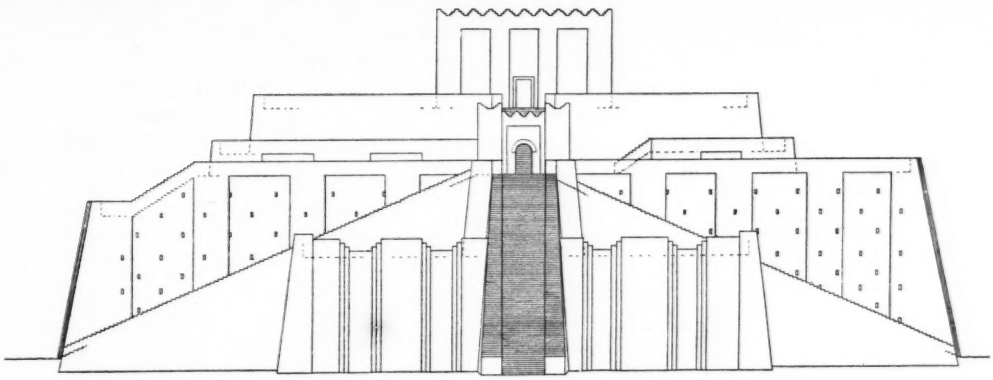
By C. Leonard Woolley.

The recent excavations at Ur have thrown new light on Biblical traditions. The Tower of Babel was a Ziggurat in all probability very like the one at Ur.

In a previous article I have described the work done at Tell el Obeid by the Joint Expedition of the British Museum and the University Museum, Philadelphia, during last winter; now I propose to give some account of the main work of the season, the clearing of the Ziggurat at Ur.

Almost every important city of ancient Babylonia boasted its Ziggurat or staged tower. In the flat alluvial plain of Mesopotamia, seamed as it then was with irrigation canals and liable in the wet season to inundation, it was an elementary precaution to choose as site for a building some natural "island" mound, or, if such were lacking, to heap up an artificial mound and build on the top of it; most of the temples and palaces of the land were raised on terraces which added to their dignity and secured them against floods. But the Ziggurat is something more than this. The Sumerians, with whom the type seems to have originated, certainly had foreign connexions and probably came down into the Valley of the Two Rivers from the hill country of the north-east. In their original home they must, like all upland folk, have been accustomed to setting up their altars and shrines "on every high hill," and indeed at all periods of their history we find them representing their gods standing or throned upon mountains – rocky mountains such as are altogether unknown in Mesopotamia. When such a people came down into the flat valley land, they must have been sadly at a loss for lack of the familiar hills whereon gods could be fitly worshipped; the "gods of the hills" would little favour a shrine low-lying on the plain, and so, to establish their communion, a pious generation set to and built mountains where Nature had none to offer. The Ziggurat is an artificial hill crowned by a temple. Then there comes in a second idea. If the Lord of Heaven lives on the hill-top, the hill is itself in some measure heaven; and so the man-made mound must not be a mere mound, it must conform to what we know of the heavens, must figure forth the celestial elements, the zones or spheres of the upper world; the form and colour of the building have their symbolic meaning and therefore their fixed tradition. The Hebrew story of the Tower of Babel (of all the Ziggurats that of Babylon was the most

THE NORTH-EAST FRONT OF THE ZIGGURAT, TAKEN FROM THE SOUTH-EAST RANGE OF CHAMBERS OF THE GREAT COURTYARD.



NORTH-EAST ELEVATION OF ZIGGURAT AT UR

SCALE 10 0 10 METRES

famous) curiously misinterprets the builders' motive; they were not seeking, like the giants of Greek legend, to pile Pelion on Ossa and take heaven by storm; they sought rather to get their prayers heard by worshipping God decently on His accustomed holy hill, and every detail of their building crystallized some pious belief.

Ravages of Time.

Unfortunately the great temple-towers of Mesopotamia have suffered so severely by time and man's destruction, that their original appearance has been a matter of conjecture. At Ur the site of the Ziggurat was known, indeed it was unmistakable, for its sloped mass of broken brick and dust and sand dominated all the mounds of the ruined city. Here in 1857 Mr. Taylor, digging for the British Museum, found remains of upper works and of a brick staircase, and by demolishing the corners of the surviving brickwork unearthed the foundation-tablets which told the story of the restoration of the tower by Nabonidus, King of Babylon, in the Sixth century B.C. Here, too, in 1919, Dr. H. R. Hall laid bare to its foundations part of one of the shorter sides of the building and proved that the ancient walls were marvellously preserved. Obviously the complete excavation of the site would throw new and valuable light upon the character of the Ziggurat in general; at the same time, it was a formidable task that lay before anyone who would undertake to shift the thousands of tons of rubbish that masked the walls, and there was little prospect of all this heavy work producing anything much in the way of museum objects; an addition to knowledge was all that the excavator could expect. I must thank the Directors of the two Museums responsible for the excavations for authorising me to spend the bulk of my season's funds on a task materially so unremunerative and, as events proved, so rich in information. For the shapeless mound of rubble concealed the best-preserved of all the staged towers of Mesopotamia, and its clearing has enabled us to reconstruct, in almost every detail, the great Ziggurat of Ur.

Season's Work.

The mound lay in the west corner of the Temenos or Sacred Enclosure, whose outline we had traced in our first season (see DISCOVERY, October, 1923), close to its S.W. wall and practically centred on a gateway in that wall reconstructed by King Nabonidus. We started work on this face and cleared down to the level of the Third Dynasty of Ur (2300-2000 B.C.), finding for the most part remains of subsidiary buildings of the Sixth century B.C. Between the double wall of the Temenos and the face of the Ziggurat there ran a series of narrow chambers divided by an entrance-court extending behind the gate. Entering by this, one had on the right a square of raised brick pavement whereon stood an ablution-basin waterproofed with a thin coating of lime-cement and furnished with a drain beneath. To the right of this the whole intramural space was occupied by rooms; to the left of the court there was a range of very narrow chambers with asphalted floors sloping down to one corner and separated by low raised gangways of brick; these had all the appearance of oil-stores where the clay oil-jars might be set in rows between the gangways, and the oozings from the jars would run down to the corner of the store and be recollected. A narrow passage separated the magazines from the Ziggurat. Whatever purpose these rooms really served, there is no doubt that on this S.W. side the lower part of the tower was completely masked by buildings themselves bounded by the Temenos wall, which was fifteen metres wide and must have reached a respectable height, so that only the upper part of the Ziggurat could have

been visible above it. Certain phrases used in the texts about Ziggurats, and in particular an inscription of Nabonidus referring to this Ziggurat of Ur, and to the S.W. side of it, seem to imply the presence in or about it of trees; actually there is no room for such in this thickly built-over area, and the only possible place (apart from the narrow stages of the tower itself, where plants in tubs might have stood) would be on the flat roof of the Temenos wall chambers; but of this there remains no tangible evidence whatsoever. The two ends of the building were also more or less masked by structures whose ruins have yet to be excavated, and it is clear that though the tower stood high above all surrounding buildings, so as to dominate the city and be its most prominent feature from any distance, yet the remaining façade, the north-east, was the only one which was fully exposed and only from this quarter could there be obtained a general impression of the Ziggurat as a whole.

SOUTH END OF THE COLUMNAR WALL OF THE GREAT COURTYARD.

When we started on the clearing of this face we were at once confronted with the difficulty of where to dispose of the mass of debris that had to be removed, for economy demanded that this should not be carried farther than was absolutely necessary, while on the other hand it was impossible to dump it on ground which might subsequently have to be excavated. Within the Temenos enclosure, N.E. of the Ziggurat and N.W. of the shrine of E-Nun-Makh excavated last year, there was a large stretch of ground so low-lying in relation to all about it as to appear hopelessly denuded by a watercourse that ran across it, and not worth the labour of digging; to prove this, prior to heaping spoil upon it, trial trenches were cut across the hollow, and at once we hit upon walls and brick pavements immediately below the surface. The hollow ground represented the courtyard of a very large rectangular building, and so far were my previsions incorrect that the pavement of this court was itself high above the level of the plain, the N.W. wall of the building being a massive buttressed wall which though ruined down virtually to pavement-level, yet stood on its outer face 2.60 metres above the road. Faced as we were with the heavy task of clearing the Ziggurat, we could not tackle the work of excavating a second great building, so after laying bare the N.W. chambers, the west corner of the court, and a strip of pavement all along the S.W. side of the same, we had to content ourselves with tracing the rest of the walls sufficiently to make clear the whole plan.

Stone Chambers.

The building, which is connected both with the Ziggurat and with the E-Nun-Makh shrine, has a single range of chambers, probably store-chambers, round three of its sides, and on the N.E. its main entrance and three independent sets of rooms like self-contained flats, which may well have been the living-quarters of priests attached to the Moon-god's temple. The whole of the centre is occupied by a paved court. The building in its present form was put up by Kuri-Galzu (*c.* 1600 B.C.), over the ruins of older work about which we as yet know little or nothing; it was repaired and the floor-level raised, by Sin-balatsu-ikbi, Assyrian governor of Ur about 650 B.C., and it was finally rebuilt, at a much higher level but on the same plan, by Nebuchadnezzar half a century later. The most remarkable feature of the building, one which goes back to the Kuri-Galzu period, is the wall along the S.W. of the court; instead of the shallow rectangular buttresses characteristic of Babylonian architecture, there was a columnar decoration; except for certain plain panels, the wall face was formed of a series of attached half-columns in moulded brick, mud-plastered and whitewashed; the columns were a metre wide, and down the centre of each ran a double T-shaped groove to relieve the monotony of the curves. In front of this there was a low sleeper wall of brick, once plastered, in the top of which were traceable shallow circular depressions, as if for the feet of wooden column-shafts; it would appear that the columned wall was really the back of an actual colonnade which sheltered a cloister-like paved way along the side of the court. At Nippur, Dr. Peters reported the discovery of a somewhat similar colonnade, but his report was discredited and the building attributed to the Sassanian period; and the German excavators at Babylon, as a result of more than ten years' work, felt themselves justified in saying that the column was unknown as an architectural feature in Babylonia until the Persian time: our discovery then is of the greatest interest,

SOUTH-WEST FACE OF THE ZIGGURAT, WITH THE NABONIDUS GATEWAY ON THE RIGHT.

carrying back as it does the use of the column to the Sixteenth century B.C.

But for the moment the main importance of this building is its relation to the Ziggurat. The floor of the courtyard was 3.80 m. below the level of the Ziggurat foundations, and the back wall of the chambers on this S.W. side was in reality the containing wall of the terrace on which the Ziggurat was built. The Ziggurat was best seen from this side, and the columned wall would, to anyone looking at it from the court, appear as the lowest feature of the tower itself.

Turning then to the Ziggurat, we find that it is a solid rectangular building measuring 61.0 metres by 41.0 metres, with its angles orientated to the points of the compass; the core is of mud-brick laid in mud-mortar, the face is of burnt brick set in bitumen or pitch, and is decorated with shallow buttresses; all the walls have a marked batter, and all at regular intervals are pierced with oblong slits going right through the burnt brickwork which are "weeper-holes," intended to let escape the moisture from the core and so prevent this swelling and bursting the outer walls. This solid mass of brickwork, which stood 15.0 metres high, was the lowest, and principal, stage of the tower. Above it were built the other platforms, each stage smaller than the one below it, but all solid throughout; and on the uppermost stood the shrine which was the object of the whole. Against the N.E. face were built three staircases which gave access to the first platform; the central flight when unearthed was found to have lost all its treads, but the two side flights were remarkably well preserved and out of the hundred steps there remained 74 on the N. side and on the S. side 91. Of the higher stages not a great deal survived. The corners had been destroyed by Taylor's work in 1857, and an upper flight of stairs in the middle of the N.E. face seems to have suffered in the same way; but enough was left, especially on the N.W. and S.W. sides, to establish the outlines and the heights of the stages; one small staircase was almost intact, and of another and more important flight on the S.E. the foundations yielded the information necessary for the plan. Mr. F. G. Newton succeeded (where perhaps no one else would have done so) in working out a restoration which utilizes every scrap of evidence available, and is supported by evidence in almost every detail. Only the temple

itself had wholly disappeared, but it was clear that this had been (in the last period) built of the blue-glazed bricks sometimes bearing the stamp of Nabonidus which were found in the rubble right up to and on the top platform ; its character was thus established, though its size and form had perforce to be guessed.

2,300 B.C.

Of the extant ruins, the whole of the lowest stage with the triple staircase and the angle-towers that separate the different flights is the original work of Ur-Engur, the first king of the Third Dynasty of Ur, who reigned about 2300 B.C. The upper stages of that period have left little trace, only one angle of the second story being identified by us, and that was badly breached by the workmen of Nabonidus, who tore down the brickwork in their search for the foundation-tablet of the original builder. In his own foundation-cones Nabonidus informs us that the old Ziggurat was built by Ur-Engur and his son Dungi, but we found no record of the latter, and if, as is probable, Nabonidus was quoting from original documents, we can only assume that the Ziggurat was begun by Ur-Engur (whose brick-stamp occurs throughout the whole of the extant early walls) and its superstructure left to be completed by his son. Very little work seems to have been done on it by later kings, and when Nabonidus started operations the upper stages must have been in a state of hopeless disrepair ; he therefore utilized the lowest stage as it stood, merely remaking the treads of the stairs, but entirely rebuilt everything above it. Our restoration shows the Ziggurat as rebuilt by the last of the Babylonian kings in the middle of the Sixth century B.C.

Three converging stairways led to a landing in the centre of the N.E. face on the level of the second stage, to which access was gained through a monumental gate. Inside the door, one could turn to the right and either walk round three sides of the building along the second platform, or one could climb a small flight of steps to the third platform and so again pass right round the tower. If one turned to the left, the path, running at first on the level, then descended by a flight of stairs to the lowest platform which extended across the S.E. end of the Ziggurat and existed only at this end ; from the centre of the platform a broad stairway cut through the edges of the upper stages led straight to the shrine above. Lastly, immediately fronting the door of entry, another flight of stairs cut through the platform edges took one directly to the highest level ; the shrine presumably had two doors, one corresponding to each of the stairs by which the top platform was approached.

Imposing Design.

Primitive as may seem at first the scheme of the Ziggurat, a simple piling-up of cube on larger cube, as a child might do with a box of toy bricks, it is really a very fine piece of design. Looking at it from the court, one had at the base the vertical lines of the columned wall accentuated by the heavy shadows of its grooving ; above this rose the Ziggurat proper, the batter of its containing walls leading the eye upward to the crowning shrine, the more sharply converging lines of the three stair-flights focussing the interest primarily on the entrance-gate high up, from which the straight-ascending stairs seen through and above the pylon carried on one's gaze to the shrine's central door. Right across this general upward and inward bearing of the architectural scheme cuts the colour decoration. The columned wall was white ; the first and second platforms of the Ziggurat, and the three stairways, were dead black, washed over with pitch ; the top platform was built of lightly-fired bright red bricks, and the shrine was of blue-glazed brick gleaming in the sun ; God's hill reproduced thus the heavenly zones.

SURGICAL ANTISEPTICS.

A FIRM of chemists announce that they have just put on the market a new antiseptic of the flavine group ; this they call Acriflavine - Neutral. This has the advantage over other members of the group in that it has no acidity, and it does not attack metals. The flavine group, which are really organic dyestuffs, came into use as antiseptics during the war, after the pioneer work of Dr. Browning and his colleagues. They appear to have little or no action upon the skin and may be used with equal effect in the presence of serum or other organic bodies. Their value in cleansing wounds is therefore obvious. The other members of the group, however, possess such acidity that they can only be used in extremely dilute solutions, and the neutral product just prepared will be more efficacious than its predecessors in that it may be used in a reasonably concentrated solution. It will thus be possible to eliminate the frequent dressing that is necessary when using the other flavine antiseptics.

A NEW POLICE TRUNCHEON.

THE U.S Chemical Warfare Service recently demonstrated before an important audience the remarkable efficacy of a mild escape of lachrymatory gas in dispersing an unruly crowd, the stream of gas being judiciously regulated by policemen.

"A Year among the Maoris."*

By Frances del Mar.

Miss del Mar has been investigating the fast vanishing native life of the Maoris on behalf of the Metropolitan Museum of New York.

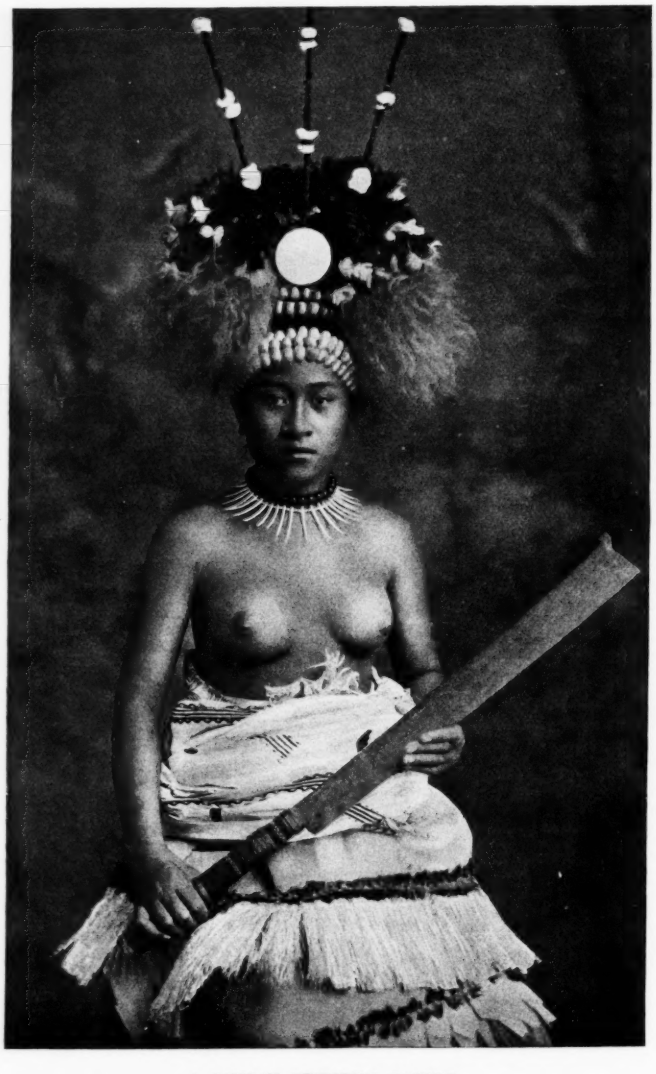
EVEN though the native population of New Zealand is again on the increase, it is as well that anything that is to be written about the art and customs of the Maori be written at once, for as can be seen from a hundred and one evidences in this book their culture is almost dead and those of their customs that are kept up are practised only occasionally and sometimes only for the edification of such ethnological students as the authoress. Miss del Mar has seen the Maoris from a new point of view. Travelling in order to make sketches for the Metropolitan Museum of New York, she has made a number of notes on subjects that have interested her and, with the aid of Mr. Pemberton, a London New Zealander, welded them into a book. About the origin of the Maoris her conclusions fit in with the Perry-Eliot-Smith theory of the megalithic track, postulating, however, for a Caucasian derivation for which she quotes Professor Macmillan Brown. This conclusion seems highly disputable; some stock similar to the Cro Magnons and the Guanches, Atlanteans in fact, or related to the early dynasties of Sumer and Egypt would satisfy better, although the lapse of time between building of the megaliths in other islands and the occupation of New Zealand must be accounted for. The authoress treats in detail the "moko" or tattoo and shows how the patterns are all built up from three straight lines placed horizontally as well as vertically over the face with a figure resembling the letter S in the centre of the forehead. The art is dying out and one of the chief survivals is the habit of tattooing a woman's lips and chin. The custom of tattooing as it was practised in New Zealand is peculiar to that country. In the South Sea Islands the design is drawn with surface pricking and in most of the Polynesian Islands merely painted on; but in New Zealand the moko is really a chiselling of the flesh. The process is described by the authoress as follows: "The tattooer seated himself on a floor mat with the patient's head on his lap. Sometimes the chisels themselves were dipped into the colouring matter, which was thus carried into the flesh. Another method was to apply the pigment to the cut with a mesh of prepared flax, and a similar mesh served as an absorbent of the blood from the incision. It was the general custom to draw the full design on the face in charcoal, and in a gourd filled with water the patient could see his face reflected. The portion that was to be carved was then scratched in with a sharpened bone, and the chiselling began. It was very painful, but it had to be borne without flinching,

TATTOOED HEADS BARTERED TO WHITE TRADERS IN EXCHANGE FOR GUNS.

* "A Year among the Maoris," by Frances del Mar. Ernest Benn, 18/6 net.

and it was the custom of the girls of the village to come and sing to the patient. But he might not be touched, as he was 'tapu'; he might not even touch his own face, nor even feed himself. Food was offered to him at the end of a long stick, and water was poured into his mouth from a calabash. If he touched anything it had to be destroyed, as it could never be used again for a common purpose."

Not only was the moko an identification; it was also a token of distinction. Only the free men were tattooed, never a slave. If the head of a slain enemy was tattooed it was treated with respect, and returned in exchange for the head of a relation slain by the enemy. These were preserved and revered by the family and tribe. Then came the "pakeha" (the white man), said the interpreter, "and he fought us with guns, and we must have guns, too; so we exchanged a tattooed head for guns and cartridges. Alas, we must give the 'pakeha' what he demands. Sometimes he demanded a whole ton of prepared flax, which took many months for men and women to prepare. We gave the flax and we gave tattooed heads. Then they came for more and more, so we hid the heads and would not trade with them. Then the 'pakehas' said we must. We could only have the guns when we gave them heads. Enemies were hunted and slain for their heads, slaves were tattooed and slain for the purpose, and with the muskets for which the Maoris traded the heads the Maoris killed the 'pakeha' in war."



A SAMOAN PRIESTESS DANCER.

The contact with Europe is shown by the following explanation of the reasons for "moko" by an old chief: "We love the beautiful in Nature," the old chief said, "the forces of which were personified in our religion, and 'moko' fulfilled a desire on the part of the Maoris to appropriate to themselves some of the decorative beauty of Nature. Nature is beautiful, and also very cruel at times; 'moko' is also beautiful, and it, too, causes suffering, the same as Nature, you see." The sophisticated sentimentality is nothing short of disgusting.

Miss del Mar gives also some interesting sidelights on the ethics of cannibalism. To kill a man and to partake of his flesh was to cast disgrace upon him and his people. It was done to satisfy a hatred, or to be revenged for a tribal injury or insult—the usual cause of war. It is said there existed a belief that the power and strength of the fallen foe were transmitted to those who partook of his flesh, but it is erroneous to suppose that cannibalism was practised under that conviction, for no man ever coveted the qualities of those he hated. The ceremony of a cannibal repast was a strict one, and the law of tapu was in operation. It was considered a great disgrace for a Maori to have his body eaten.

If Livy's Books Had Been Found.

By Prof. R. S. Conway, Litt.D., F.B.A.

Hon. Dott. Univ. (Padua).

Even if Fusco is a fraud this article is important. It tells why the reported discovery of the missing books of Livy aroused such enormous interest. It explains why scholars hope and trust that some day the missing manuscripts will be found. Professor Conway is the greatest living authority on Livy.

As I write in mid-September, this mystery is deeper than ever. The great announcement was made four weeks ago on the cover of the *Rivista Indo-Greco-Italica* (the chief organ of classical study in Italy) by its editor, a distinguished scholar, Professor Ribezzo.

From him we learnt, though only, as he was careful to say, on the word of Dr. Di Martino Fusco, himself the editor of a smaller learned organ called the *Mouseion*, that the said Doctor had found a whole series of manuscripts, in writing which could not be later than the sixth century A.D., containing the whole of Livy's famous history of Rome, "From the Foundation of the City," as he called it. We know the extent of this great work because we possess curt summaries of its Books, and the last is numbered 142. These carry the history of Rome down to the 22nd year of Augustus's reign, that is, to nine years before the birth of Christ. Livy himself, as we know otherwise, outlived Augustus by three years and died A.D. 17 in his 77th year.

Livy therefore saw the whole of what has often been called the most wonderful period of human history, the reign of the first Roman Emperor. It is, of course, the age in which Christ Himself was born; and humanly speaking it seems as if no other period in the course of recorded history could have afforded the same possibilities for the growth and spread of a great humanising religion. It was, in fact, the first forty-five years of peace and good government and free inter-communication that the world, as a whole, had ever enjoyed; and it had been preceded by a hundred years of war whose successive convulsions had afflicted every part of the known world, even the shores of Britain.

The one and only thing that Livy achieved, so far as we know, was to write his history; and if we could have the whole life-work of a contemporary of Augustus and a friend of Virgil, our gain in the nearness with which we could approach the moving story of those wars and that great peace, would be difficult to measure. It would certainly be a delight.

As it is, at present we possess only thirty-five Books (besides a few fragments) out of the total. The narrative of these Books stops early in the second century B.C.; and further, since the Second Decade (Books XI-XX) is among those that have been hitherto lost, the total information which we possess about the third century B.C. comes from other sources and is deplorably scanty.

But this was the period during which, more than in any other, the inspiring and creative influence of Greek writers began to shape Roman ideas, both in politics and everything else. And it happens that it is this Second Decade which Di Martino stated specifically that he had engaged in copying out; and even if this alone were true and the rest a mere delusion, the gain to European literature would be greater than any that has happened since 1509, when the manuscript of Tacitus's "Annals" was brought to Rome to Cardinal Giovanni de' Medici (afterwards Leo X) from a monastery in Westphalia.

While Dr. Di Martino's warrant for his statement is still being sadly debated, and while he himself, for unknown reasons, differs or refuses information, the question of the reality of the find must be left to be settled elsewhere. The pages of DISCOVERY are meant for things that are known. My object here is to enable the reader to understand what kind of thing it is that Di Martino said he had found, and in what the importance and interest of such a find would consist. For the moment we must be content with the fact that the whole learned world outside Italy and everybody who can read in Italy itself has been willing to think of it, provisionally, as something different from the vulgar frauds which have been attempted from time to time in almost every branch of knowledge.

The manuscript, according to Di Martino, was Uncial, that is to say, it was written in a kind of hand intermediate between capital letters and the ordinary characters which we use in writing ourselves. It is quite conceivable, as M. Salomon Reinach and others have pointed out, that some new part of Livy's works written in this script should have survived from the sixth century. Had the statement been that the manuscript was of the tenth or eleventh century, it would have been almost incredible; for we have enough information about what scribes were doing in that period to be sure that they knew nothing of any Books of Livy that we do not possess.

The photograph which accompanies this article is of the second page of the most famous Uncial Codex* which we possess, and shows what a page of such a manuscript looks like; the reader can guess the great number of such pages needed to contain any substantial piece of literature. Roughly speaking, each contains about a thousand letters; whereas each page of DISCOVERY contains about a thousand words. Hence one might calculate that something like eight or ten pages of Uncial manuscript would be needed to reproduce a single page of DISCOVERY.

This manuscript itself, now in Paris, was probably written in the fifth century A.D.; its vellum is yellow with age and almost everywhere transparent. It originally contained the Third Decade with the story of the Hannibalic War; but it is mutilated at the beginning and end, and has suffered much from corrections imposed upon it by later hands. At present it has about 470 leaves, that is, 940 pages.

But probably most of the readers of DISCOVERY will be more interested in the second question, Why should we desire to have the whole of Livy's work? The chief answers, beside the enormous gain in our knowledge of history, are two: first, that Livy had one of the noblest, frankest, and most genial minds that ever gave themselves to the study of human history, so that to know more of him is to know more of one who is, at the lowest estimate, an inspiriting companion; and, secondly, that his keen and warm-hearted imagination fills every scene that he describes, so that in reading his history we see a series of lively pictures of men and women, strangely like ourselves, in times strangely different.

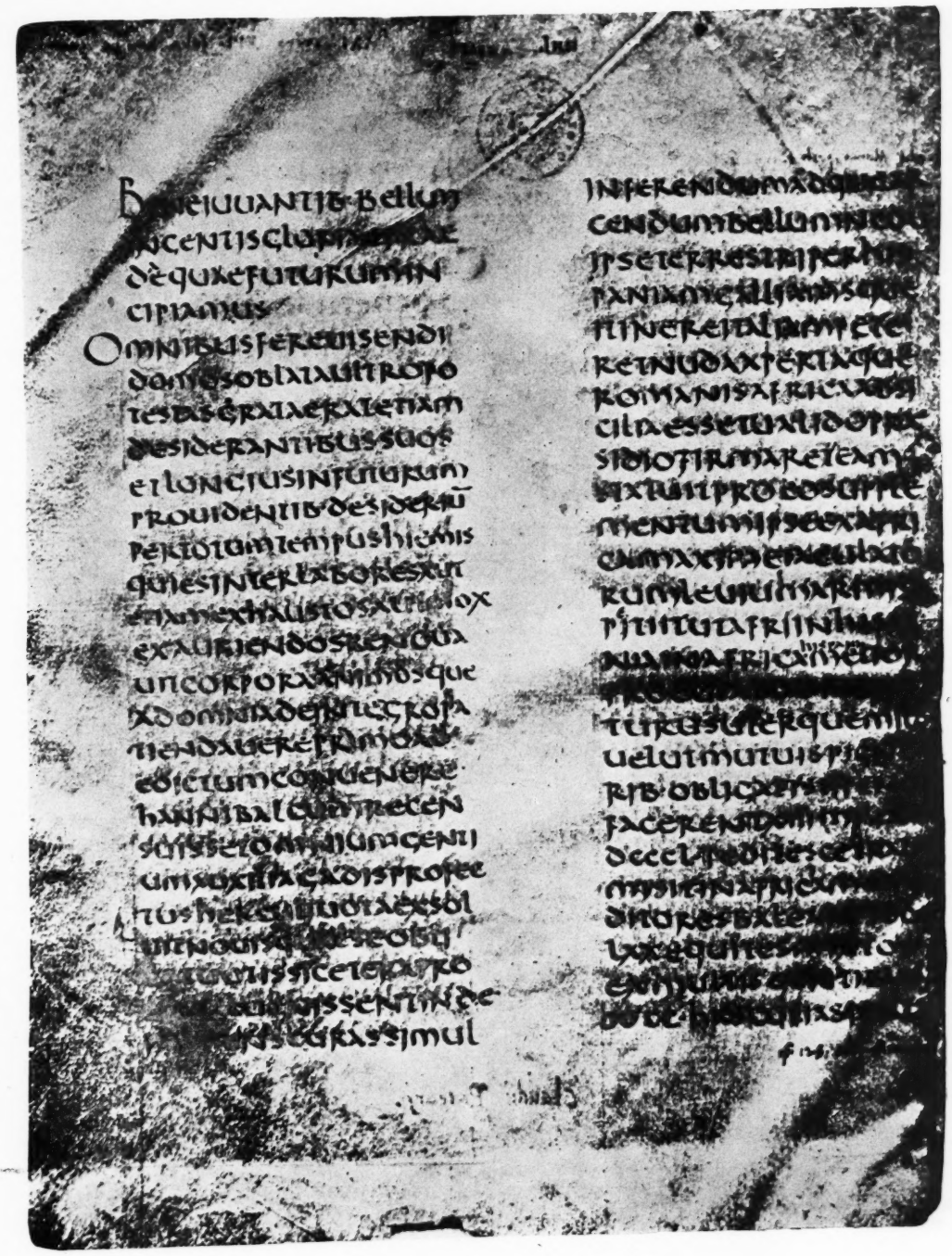
We must, of course, distinguish, as schoolmasters very often fail to do, these vital parts of his work, from the mere annual chronicles that he inserted from a sense of duty, recording a number of events which he found attributed to particular years, but to which he attached no importance. In these portions he was following the old annalistic tradition from which no ancient historian ever completely escaped. Fortunately, they occupy a comparatively small part of any Book, and can be very easily omitted; in some Books, like the second, the eighth, and the twenty-first, they hardly appear at all. And we may be sure that if we ever were so fortunate as to recover the Books that dealt with his own times, we should find nothing of the sort.

Many numbers of DISCOVERY could be filled by examples of the martial or romantic stories which Livy loves to tell. "How Horatius kept the bridge," or the picture of Coriolanus' mother, wife and child entreating him to spare his native city, from Book II; the contrasted but both thoroughly Roman stories of the merciless Torquotus and the stern, but not inexorable Papirius in Book VIII; the tragic end of Capua after a long siege, or the Napoleonic achievements of the young Scipio in Spain in Book XXVI; above all the splendid tragedy of Sophonisba with the subtly drawn characters of Scipio and Masinissa in Book XXX—any one of these can be read with delight even in a translation. Let me rather choose an example which shows Livy's power of bringing out the dramatic elements of a scene. The incident had been already mildly recorded by the dull (though deserving) Greek historian Polybius, long before Livy's day.

The mutiny at Sucro in 206 B.C. was one of the most dangerous points in his career, as it threatened the Roman supremacy in Spain. He had been ill; the government had been dilatory with the soldiers' pay; and the soldiers had actually chosen two obscure persons named Atrius and Albius to replace their generals, who handled the situation in a masterly way, securing all the ringleaders beforehand, and deluding the mutineers into thinking that his loyal troops had been sent far away. Of the speech which he made to them when they, mainly unarmed, and without their leaders, surrounded his tribunal and were themselves surrounded by loyal troops, Polybius and Livy give reports which in substance are identical, but in style so different that they could hardly be thought the utterance of the same man. I doubt whether any mutineer who heard the speech which Polybius gives would have been influenced by any motive but that of fear; whereas the speech given by Livy is an appeal to the warmest feelings of the soldiers—their old loyalty to Rome, their sympathy for their general still weak from illness, and their gratitude for his forgiveness. Livy shows us Scipio entering into the feelings of the mutineers with wonderful comprehension. He even arouses their sense of humour against themselves, a sentiment which teachers know to be a powerful element in penitence, by dwelling on the ill-omened names of their chosen leaders, Atrius and Albius, "Blackie" and "Whitie," a thing which Scipio, like every Roman, was sure to do with a certain degree of real belief in the omen. The crowning touch is where he puts on a level in the same sentence his own sickness of body with their sickness of mind, followed by an impassioned expression of his grief at their unfaithfulness.

One small but significant indication of the difference in the colour of the two accounts deserves mention. The speech in Polybius contains some 520 words, in

* A few notes on the special peculiarities of this page are added at the end of this article.



FROM THE PARIS UNCIAL CODEX.

Circa A.D. 500. (Illustration half actual size).

If the Livy manuscripts had been found they would have been written in characters like this. Photo shows reverse of first surviving leaf (Book XXI, c. 21, 6), describing Hannibal's start from Spain. The first words are the end of his speech giving the soldiers their last spell of "home leave." See article and Notes for details.

which forms of the first person singular occur 14 times—i.e., once in every 37 words. In Livy the speech occupies about 1,025 words, and there are no less than 64 occurrences of *ego*, or *meus* or verbs in the first person singular—i.e., one word in every 16—a frequency more than double. Scipio's whole career shows that Livy's picture is true. Polybius can see no fault whatever in his perfect hero and cannot explain his subsequent fall, and his death in virtual exile.

Perhaps the last paragraph of the speech in the two versions will be enough to warrant this judgment and to give some picture of Scipio.

Here is the end of the speech given by Polybius (xi. 29):

> "I should like then to ask—what was it in which you trusted? Surely not in the skill and valour of the leaders whom you have now elected, or in the axes which were borne in front of them—men of whom I will not deign to say another word. All this, soldiers, is futile; nor will you be able to allege even the smallest just complaint. . . . Wherefore I will undertake your defence by a plea that all the world will acknowledge to hold good. And it is, that a crowd is ever easily induced to any error. Therefore it is that crowds are like the sea, which in its own nature is safe and quiet: but when the winds fall violently upon it, takes the character of the blasts which lash it into fury; thus a multitude also is ever found to be what its counsellors are. Acting on this consideration, I and my fellow-officers hereby offer you pardon for the past: but to the guilty authors of the mutiny we are resolved to show no mercy, but to punish them as their misconduct deserves.

Here is Livy's version of the same (28, 29, 2-8):

> "But what grief of heart, what fit of anger hath incited and provoked you? Grant that your wages were paid later by a few days, whilst your General lay sick; was that a sufficient cause for you to proclaim open war against your country? Was that enough to cause you to revolt from the people of Rome, and turn to the barbarians, and to spare no law of God and man, and make shipwreck of conscience and common honesty? Soldiers, you were distraught and out of your wits. I was not myself prostrated by a more powerful sickness in body, than ye were in mind. I tremble to think or say what folk believed, what they hoped, what they wished. Let all be forgotten, if it be possible: if not, let us not speak of it, howsoever we do, but cover it up in silence. I cannot deny that my words have seemed harsh and bitter unto you; but how much more cruel think ye, are your deeds? And if ye deem it reasonable that I should bear the things that ye have done, can ye not abide even to hear them all recounted? But even these matters shall be no more laid against you from henceforth. Would God ye could as soon forget them, as I will. And therefore as touching you all in general, if ye repent for your folly, I shall be content, and think you punished to the full. But as for Albius and Atrius, with the rest of the authors of this detestable mutiny, they shall make amends for their transgression, with their life's blood. The spectacle of their punishment ought not to seem unto you grievous, but rather a delectable sight, if ye be come again to your right mind. For their intent did no more cruel mischief to any man than to yourselves."

Well, you say, Livy was more of an orator than Polybius. He was indeed; for he understood the strength of human passion and had the courage and the power to portary it.

NOTE.

English translations of Livy may be had in the Everyman Series, and with the Latin opposite in the Loeb Series. Both are reasonably trustworthy. But the great Elizabethan translation by Philemon Holland, which can often be obtained at second-hand, though now and then it errs a little, gives a quite unmatched representation of the fire and wealth of colour in the original. The rendering just given is based on this; that of Polybius is mainly from E. S. Shuckburgh's admirable version of that author.

NOTES TO THE PHOTOGRAPH.

This page shows one or two characteristic features of the manuscript which some readers may be interested to notice.

Col. I, l. 3, *and last line but* 3: the *que* was first of all written *quae*, as it often is; but the corrector has drawn a vertical line through the *a*.

Col. II, l. 1: The preposition *in* has been omitted before the word *inferendum* either by P himself (*i.e.*, the scribe who first wrote this manuscript) or in the manuscript from which he copied. It has been restored by a quite certain conjecture.

Col. II, l. 4: The proper reading is *Hispaniam Galliasque*, where the plural of the second name denotes the different parts of Gaulish territory Trans-Alpine and Cis-Alpine. But since this expression seemed strange to the scribe of the text which P afterwards copied, he first wrote *Galliam* like the preceding *Hispaniam*; then looking again at the text he had to copy, he noticed his mistake and wrote *S* on the top of the *M*, meaning that the reader was to substitute *S* for *M*. Then P with this before him thinks that both the *M* and the *S* have got to be put in, and writes the nonsense word *Galliams*; then the first corrector puts a dot above the *M* meaning that *M* is to be disregarded; then another kind corrector draws a line through the *M* to make this clearer still.

Col. II, l. 9: Exactly the same thing has happened to a superfluous *t* written in *firmaret* (instead of *firmare*). The correctors have again been on P's track.

Col. II, ll. 14 *and* 15: Any student who compares this photograph with a printed text of Livy will see the mistakes which P (or his predecessors) made, and which a corrector has tried to put right.

UNIVERSITY OF LONDON

A MOST interesting programme of the University Extension Lectures for the coming session has just been issued by the University of London, South Kensington. In addition to the central courses which will be delivered in the City, lectures will be given at about fifty-five local centres in different parts of London and the suburbs. The subjects treated cover a wide range, and courses of great interest in the departments of Literature, Geography, Painting, Music, History, Science, Architecture and Economics are included in the list. In the direction of teaching of a non-vocational character, important work is being done by the Board.

Apparatus Hunting.

By Hugh Pollard.

Do you know the queer by-ways where old apparatus can be bought for a trifle? There is perhaps as much romance in scientific curiosities as in any other form of collecting.

SCIENTIFIC interests and a great depth of purse do not customarily go together. A knowledge of certain London by-ways is therefore a very useful asset when a supply of cheap material for experimental purposes is needed. Incidentally, scientific beachcombing is just as absorbing as any other form of collecting and occasional rare finds result. Inevitably the dealers get the pick of the market, yet the knowledgeable amateur may have good luck.

Farringdon Street is always interesting, for there the stalls stretch from the meat market to far beyond Farringdon Street District Railway Station. There you will find a galaxy of junk, much of it without interest, some full of odd possibilities. There are bookstalls, new stalls full of trashy but inexpensive wireless parts, a stall of old coins—yes, all kinds of coins, Roman, Greek, and even savage tokens. The prices are not excessive, but after all your stallholder pays no rent to speak of, issues no catalogue, and has few overhead charges.

On the Barrows.

The barrows that specialise in ex-disposals gear are perhaps the most profitable. Are you a microscopist or have you a fancy for optical material? Prisms out of range-finders and expensive gunsights, sixpence apiece. Most of those exhibited are chipped, but ask for a good pair and they will be produced for the same price. Lenses of all kinds, achromatic combinations in cells, erector combinations, draw-tubes, bits of Barr and Stroud range-finders, complete ones if you need them. The market has almost a fixed price for lenses—sixpence each. Big ones are dearer. A three-inch astronomical glass cost me half a crown.

"Yes," you may say, "these bits are possibly interesting, but even if in condition something will be lacking. How can you mount them up?" The answer is simple. The Army and Navy Stores keep a wonderful stuff called plastic wood, and a special fluid for softening it and cleaning one's hands—for it is awfully adhesive. It is a mixture of wood dust and some liquid cellulose solution. With this wonderful material you can mend or mount up anything, for it moulds like stiff dough and sets like hard wood. It should be better known to amateurs with a mechanical bent.

Before wireless set in, the stalls were a good hunting-ground for odd electrical gear. There is still some to be found to-day, but most of it has been absorbed by wireless fiends. Those interested in collecting early telephone and telegraph instruments will, however, still find that the market yields odd pieces of historical interest. They are seldom complete, though, for many many years ago someone bought for a shilling some instrument with about an ounce of platinum in it. The legend has done harm, for invariably the stallholder unscrews and removes any bright metal parts which might be platinum. They are inevitably German silver or a cheap tungsten alloy in point of fact—but he runs no risks and prefers to ruin a complete instrument rather than run the hazard of such a disaster as letting something get past him.

Collectors' Pieces.

Very curious early electrical and physical instruments turn up on the stalls. In their time they have represented possibly the very best of their day. They may have been the actual working tools of leaders of science whose names we still hold in honour. Age does not matter in the market, and alembics used by the last alchemists might be found some day upon a stall. One odd curio I found there long since was something beyond the realm of science—a real magician's wand. It was not easy to identify it for what it was, for it was a slender rod of ebony, like a conductor's baton. One end was tipped with a silver band, the other with copper, and, strangest of all, a magnetised steel wire ran through from end to end. Zodiacal signs on the silver band were the unusual outward sign which caught my attention. These and some Hebrew letters were repeated on the deep copper band at the other end.

I was never able to date the odd wand with any certainty, but am inclined to believe that it cannot have been much more than a century old, possibly even nineteenth-century, a relic of the days of Mesmer and the early psycho-therapists who practised "animal-magnetism." A later form of "magic wand" is a long ebonite handle with a ring of ebonite containing a lens and a luminous compound. It is an apparatus for observing the so-called N-rays, once believed to be

given off by the human body. In theory the luminescence waxed and waned as the invisible energy waves varied in intensity according to muscular or mental effort. Actually the odd disc does appear to flicker rhythmically but, unless my memory tricks me, this has been proved to be an optical phenomenon due to fatigue of the optic nerve. Incidentally, fatigue of the optic nerve explains most of the odd things seen at seances by the credulous.

MR. STEVENS AT THE DESK.

No less interesting than Farringdon Street is the Caledonian Market, but this is somewhat harder of access and, unlike the Farringdon Street market which is in progress every day, only takes place on Friday mornings. The goods are variable but on the whole there is a better and less battered collection; still, "bits" predominate. It does offer occasional bargains. The body and draw-tube of a good Swift microscope fitted with a revolving objective changer and two Ross objectives—a 1-in. and a $\frac{1}{6}$-in.—all very dirty, yet perfectly sound, is not dear at three shillings and sixpence the lot!

From the Caledonian Market, too, came a pair of beautiful Joseph Manton flintlock duelling pistols with platinum touch-holes and inlay. The label in the old mahogany case bore the name of a long-dead officer who was commissioned in 1806, Dr. Price of the 17th Lancers. Among the bullets, tow and odd accessories in the case were half a dozen tortoiseshell-handled lancets, a small and ominous saw, and an odd piece of brass tube-work, which bore no relation to armourers' work and seemed oddly clinical.

It is now in the Museum of the Royal College of Surgeons, whose curator was able to identify it from drawings in a book. The Museum possessed no specimen. It was a curious and forgotten instrument. A tobacco-smoke enema in the surgeon's case of pistols throws a curious sidelight on medical practice on the field of honour, for in those days tobacco-smoke was believed to be valuable for restoring sufferers from collapse or shock.

From the markets let us now pass to Stevens' Auction Rooms, as celebrated for the sale of scientific and ethnological collections as Christie's for works of art. Every Friday there is a sale of cameras and general scientific apparatus at Stevens'. Twice a month there are also sales of zoological, entomological and kindred collections.

There is no doubt that Stevens' is an excellent hunting-ground for anyone requiring any scientific apparatus, for there is no end to the diversity of the lots which appear and normally the prices are low. Apparatus which is old-fashioned goes for very little, and one can often pick up bargains such as first-class mahogany half-plate or large cameras for a tithe of their original cost. Electrical apparatus of all kinds, tools, microscopes, surveying instruments, astronomical equipment, meteorological and medical apparatus figure in practically every sale. The rooms are always worth a visit, for a lot simply marked "Box of sundry scientific apparatus," may contain precisely something you have long been looking for.

IN THE FARRINGDON ROAD.

Another place worth an occasional visit is the Medical Disposal Stores of Geo. Armstrong & Cohen at Wood Lane, Shepherd's Bush. Here is gathered together all the vast surplus of hospital and laboratory equipment left over from the war. The biologist will find everything for his needs at second-hand prices.

Some New Apparatus sent for Review.

Arrangements have been made by which DISCOVERY *will report on new apparatus of general interest sent to the office for test.*

THE smallest practical modern microscope designed to take standard objectives and eyepieces has now been put on the market by Messrs. R. & J. Beck, one of the oldest and best-known makers of microscopes in the world. It folds into a case five inches long, two inches wide and two and a half inches deep and will slip into a coat pocket.

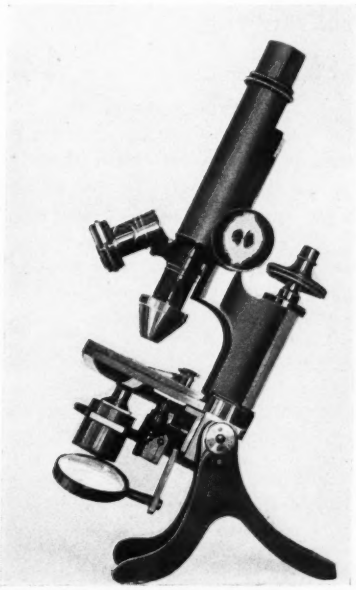
BECK "BABY LONDON"

In the past small microscopes have not been made to take the standardised objectives which fit all big instruments whether American, British or Continental. As a result they could rarely be used for serious work.

The new "Baby London" can actually be used with the 1-12th in. oil-immersion high-powered lenses used for bacteriological research, but is primarily designed for the biologist, metallurgist or zoologist who needs the smallest of portable yet precise instruments.

The novelty is mainly in the fine adjustment. In place of the usual rack and pinion or micrometer screws moving the tube carrying the optical system toward the object on the stage, the latter moves toward the tube. This is done in a new way. The stage is hinged at the top of its tripod and is normally rigid and at right angles to the optical axis of the microscope. Fine focussing is, however, perfectly achieved by screwing a single milled-head micrometer screw which moves the stage and the slide so that they rotate very slightly about the hinge, thus bringing the object under examination nearer to the front lens of the objective.

This system is theoretically incorrect, as it has always been a fixed law of microscope design that the object should lie in a rigid plane at right angles to the optical axis of the instrument. Like many laws built on theory this is one that can be broken in practice and the slight angular movement of the stage does not affect the instrument's power of resolution at all.



CHAPMAN AND ALLDRIDGE VERTICAL ILLUMINATOR OBJECTIVES.

With this tiny instrument and a normal battery of objectives and eyepieces from any standard microscope any range of magnification up to 900 diameters can be readily secured. A telescopic draw-tube enables objectives built for instruments of different tube-length to be used. An Abbe condenser and substage mount is also supplied.

The little instrument worked astonishingly well under tests, and is undoubtedly the most practical portable microscope yet designed. The naturalist will find it invaluable and it should further find a very wide range of practical applications by all who need a portable compound microscope in their work. The price is low for an instrument of such all-round efficiency, and no higher praise need be accorded to the mechanical accuracy, finish, and quality than to say it is Beck, which means a very high standard of workmanship indeed.

NEW VERTICAL ILLUMINATOR OBJECTIVES.

We have received for test from Messrs. Chapman and Alldridge two of their new combined objective and vertical illuminators—one of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ mm. with N.A. .54 with an illuminator of .62-.85, and one of 16 mm., N.A. .28, illuminator .58-.82. Both are substantial and well made both mechanically and optically, and work eminently satisfactorily under tests.

Most high-power microscope work is done on thin sections of translucent materials such as the body tissues or infinitely thin sections of plant stems. Opaque objects such as minerals, slabs of metal, or any large or small solid bodies have to be examined by indirect or reflected illumination. In the past this has been done by interposing either prisms or thin glass reflectors in an attachment between the objective and the body of the microscope and passing the light down on to the object through the lenses of the objective. This system was troublesome and inefficient as refraction from the various glass surfaces absorbed more than half the available light.

The new Chapman and Alldridge objectives do not transmit the light down the tube of the micoscope in the ordinary way. They pass the light round the outside of the objective tube and focus it to an intense point of illumination at the exact point where the object under survey is in focus.

This is achieved in a novel manner. A tubular mirror cut at an angle of 45° surrounds the tube containing the lenses of the objective. The beam of light falling on this mirror is reflected down through a series of ring-shaped parabolic reflectors which are also built round the objective, and which converge the light beams to a point on the object under observation.

The new objectives present a peculiar appearance, looking more like shell fuses than normal microscope objectives. This appearance is due to the rigid brass casing surrounding the parabolic reflectors. Optically these are the same as those used for high-power dark-ground illumination for bacteriological research.

The worker who knows what a trouble it is to arrange vertical illumination with ordinary objectives will welcome the new type which are no more trouble to use than ordinary objectives for transparent objects. The saving of time is very marked, and they are particularly valuable for micro-photographic work where glare from the illumination system is a permanent nuisance. They can be most cordially recommended to all whose work involves the examination of opaque specimens under vertical illumination.

THE SETTLERS' ASSOCIATION.

One of the most successful efforts that have been made to find a future for ex-Army men is known as "The 1820 Memorial Settlers' Association." Its name is derived from the fact that, in 1820, some 3,500 British emigrants left their homes, owing to the hard times following the exhausting strain of the Napoleonic Wars, for South Africa. This body of folk, who were known as the 1820 settlers, are the ancestors of some 150,000 of the most reliable citizens of the South African community at the present day.

The present Settlers' Association commemorates their success and seeks to perpetuate it by judicious and properly conducted emigration and land settlement on the most scientific and sane lines. South Africa wants new blood and, until it gets it, it will not take its proper place in the great agricultural and pastoral communities of the world. From the very beginning the present Association has declined to embark on any land purchase for settlement purposes. What it does is this. The London and the India Committees select prospective settlers whom they consider are likely to become successful agriculturists and good citizens. The selected settler has to satisfy the Committees as to his health and as to his character. He must be able to produce a capital of £1,500 for a single man and of £2,000 for a married man. This, however, is not called up immediately. On selection, the Committees secure for the settler reduced steamship fares to South Africa and on landing a course of free training in farming for a period of one or two years with a farmer whose reputation is well established. They further offer advice by disinterested experts to the settler when he is prepared to take up land. He is met on his arrival at Cape Town and is seen through the Customs, and has hotel accommodation found for him.

Book Reviews.

Tantalus, or the Future of Man. By F. C. S. SCHILLER. (Kegan Paul. 2*s.* 6*d.*).

Dr. Schiller voices a discontent with the lines along which man is developing or failing to develop, very similar to that of most of our present-day thinkers. He points out that man's physical evolution ceased with the Cro-magnons, and that the Great War proved that in the main humanity is still Yahoo-manity. Again, like so many, chief among them Tolstoy and the Shaw of "Androcles," he sees that Christianity has never been given a fair trial and that in it lies the key to our difficulties; but for the present he thinks that man's only hope is to take his own evolution in hand along the lines of Eugenics, controlled by an all-knowing psychologist, who seems to stand to the nineteen-twenties in much the same position as the doctor in the preceding decade, as the modern equivalent to Fraser's priest-king. The book, directed in some part as a reply to Haldane's "Daedalus" and Bertrand Russell's "Icarus," if it breaks no new ground, at least puts very clearly the great question that confronts us and attempts to answer it.

Introduction to Modern Philosophy. C. E. M. JOAD. (Oxford University Press. 2*s.* 6*d.*).

The photograph of M. Bergson that stands as frontispiece to the book is from the layman's point of view a very just selection, for of all the philosophies outlined in this book he alone propounds a system of thought that is clear to anyone untrained in the niceties of logic and metaphysics, and his theory of creative evolution alone shapes with the present-day thought on more general lines. The realists seem to confine themselves too closely to definitions and to keep themselves aloof from problems of more urgent importance to man's welfare, science, religion and art. Croce's identification of the intuition and the image is refuted by the aesthetic theories of many who have fallen under the spell of psycho-analysis; much of his thought derives from Shelley's discovery that action is a form of expression no different in essence from the poet's. One feels that language cannot express what Croce is trying to tell us. With Bergson, on the other hand, we are more at home; his ideas are akin to those that are rife in other realms of man's activities, to the theories of Lamarck, Einstein and the Theosophists. The book is a very capable summary of a subject which it is impossible adequately to summarize.

Extinct Plants and Problems of Evolution. By DR. DUKINFIELD H. SCOTT, F.R.S. (Macmillan and Co. 1924. 10*s.* 6*d.*).

This well-illustrated book is founded on a course of lectures delivered before a general audience at the University College of Wales, Aberystwyth, in 1922; the subject is presented in a form that is intelligible to readers who have not made a special study of Botany or Geology. The author's object is, first, to explain the nature of the problems suggested by the word Evolution, and then to consider some of the better known records of plant-life found in the rocks of the earth's crust in their relation to the history of plant-life.

The idea of evolution is, as Dr. Scott says, "immensely older than the time of Darwin"; but to most people evolution means Darwinism. The joint papers of Darwin and Wallace read to the Linnean Society in 1858 and the publication of the "Origin of Species" in the following year laid the foundations of the Darwinian doctrine, foundations on which various superstructures have been erected and often demolished. Even the foundation stones of the Darwinian theory have been considerably hacked about. In the first chapter an admirably clear account is given of the recent development of opinion on evolutionary questions; it is probably true to say that many biologists find it much more difficult at the present time than it was a few decades ago to recite any definite creed. Old beliefs have been shaken or discarded, and many of us are now in a state of doubt. We accept the main idea of evolution as an established fact, but the methods by which new forms of life have arisen are still in great measure an unsolved mystery. The experimental method of attack so successfully inaugurated by the Austrian Abbot, Gregor Mendel, in the Monastery Garden at Brünn has taught us much of the laws of inheritance; the comparative study of lower forms of life, and of the gradual development of animals and plants from a microscopic fertilized egg have furnished illustrations of progress from the simple to the more and more complex; but it is only a partial and very incomplete view that we can obtain by even the most intensive study of organisms as they exist to-day. We must try to decipher the fragmentary history of the plant and animal kingdoms which is preserved in the sedimentary rocks of successive geological ages. We cannot hope to discover in the inconceivably ancient rocks of the earlier periods any traces of such simple organisms as we imagine must have led the age-long procession; the oldest plants which are preserved in a state to be examined in detail, though in some important respects different from any in existence to-day, are far advanced in organisation and far removed from any simple ancestral type. The study of the relics of ancient plants—relics which are sometimes preserved in an almost perfect state—reveals a series of forms many of which belong to groups that are now unknown, while others show more or less well marked affinity to living species. We see certain families gradually increasing in importance, smaller plants succeeded by larger and relatively simple construction, giving place to greater complexity as we pass from older to newer rocks. Sooner or later progress is replaced by retrogression; evolution seems to be in the wrong direction; existing members of a group are smaller and simpler than their extinct ancestors. The history of the plant-world is in part at least a history of successive dynasties which reached their maximum development at different times and then either died out or were continued by humbler representatives. Evolution though in one sense continuous has in another sense been discontinuous; as we ascend the geological series new forms a fear from time to time and new dynasties rise to a dominant position with apparent rapidity. The search for origins and for light on the past history of existing groups and families is extraordinarily fascinating; the more we know of the plants that have been the more difficult it is to think of evolution as a continuous process of development.

Dr. Scott has given a series of pictures of the plant-world; he begins with the plants of the present day and works backwards through the ages. He states the facts and the difficulties clearly, and candidly admits that while we know a good deal about extinct plants we do not as yet know enough to throw much light on the problems of their evolution.

Dr. Scott's book is particularly welcome not only because it is the work of a leading authority on Fossil Plants, and is written in a style singularly free from dogmatism and prejudice;

but because it can be confidently recommended as a much needed corrective to the view, based on ignorance, that a study of the history of the plant-world provides a solution of the problems of Evolution.

College Manual of Optics. By LLOYD WILLIAM TAYLOR. (Ginn and Co. 12*s.* 6*d.*).

This is a revised and partly rewritten edition of a work that has been used for twenty years by students of the University of Chicago. It is a book for serious students who have passed the elementary stages of the subject, in which theoretical and laboratory work is co-ordinated as far as this is possible. It confines itself principally to the subjects of lenses, diffraction, prisms, interference, and of polarised light, but it deals very adequately with these subjects. It is written from the modern point of view and escapes in an astonishing way the dead hand of the past. It is a better book than its laconic title implies, and is not unworthy of the laboratory that has been directed in our time by Michelson and by Millikan.

The Theory of Relativity. By ARCHIBALD HENDERSON, ALLAN WILSON HOBBS, and JOHN WAYNE LASLEY, Jr. (Chapel Hill, N.C.: The University of North Carolina Press. London: Humphrey Milford. 11*s.* 6*d.*).

The object of this volume on Relativity by members of the department of mathematics in the University of North Carolina is to give in short compass the essentials of Relativity. Its hundred pages may be read by mathematicians without reference to another work. In Chapter I are described some experimental anticipations of the theory. Chapter II describes the Special Theory. Chapter III, besides describing the General Theory, contains sections on the theory of tensors. These chapters are based principally on the writings of Einstein and of Eddington, Chapter IV deals with the curvature of manifolds, describing in turn the curvatures of Gauss, of Riemann, and of Einstein.

This book is for students of the higher mathematics only. It has been carefully compiled and made as clear as possible, but it possesses no merits, and describes no developments, that are not contained in English works already published.

Sigmund Freud. By FRITZ WITTELS. Translated by EDEN and CEDAR PAUL. (George Allen and Unwin. 10*s.* 6*d.*).

Wittels was a devout Freudian from 1905 till 1910 but, in the summer of the latter year, a personal difference with Freud led him to leave the wonderful Austrian Jew who has had so remarkable an influence upon contemporary psychology. A brief period in the wilderness preceded his attachment to Stekel, the great unraveller of dreams, who was himself expelled from the main body in 1912, and is now very markedly in the opposition camp. These experiences, an intimate knowledge of psycho-analysis, a wide, gossipy, almost a gentleman-with-the-duster-knowledge of its continental exponents, are his qualifications for writing the first full-length description of Freud's life and work to appear in English.

The book, however, describes more than this. It reveals what extraordinary people the continental psychologists of the psycho-analytical school are. Many of us have believed that truth, especially unpleasant truth, was the object of their curious investigations, but this book shows that truth is a matter of cliques, that some mysteries there are which cannot be shared, and that between those who have been expelled from the true fold and those inside of it there must be no friendly dealings. They cannot, it appears, live in harmony with one another like rival scientists or even like rival politicians. They resemble more closely rival vendors of patent medicines who beg of you to see that their signature is on every box you buy, and not to be fobbed off with inferior imitations made by the other fellow.

The first nine chapters of the book describe Freud's principal ideas in detail, his personal characteristics, and the main influence on his life. There are chapters on the psychologists Adler, Jung, and Stekel, and on special subjects like narcissism. The bibliography at the end is confined principally to the writings of Freud and his rivals. The names of only two Englishmen appear, and one of these is Shakespeare, dragged in because he wrote Hamlet. In spite of obvious defects—for most of the book is either gossipy biography or the usual well-known stuff about complexes—the book should be of interest to those who follow psycho-analysis. The translation, which must have been a very difficult task, has been done really admirably.

A Textbook of Geology. Part II.—Historical Geology. By CHARLES SCHUCHERT. Professor Emeritus of Palaeontology in Yale University. (Chapman and Hall. 22*s.* 6*d.* net).

This is very definitely a book for the general reader as well as the student. It is noticeable that many books from American sources are far better adapted for the general reader than the more specialised British standard books. The preface to this volume affords some light on this. The American student who includes Geology in his course has had no previous course in Zoology or Botany. As a result a textbook to cover the subject is obliged to include sufficient elementary Zoology and Botany or rather simple explanations as it goes along. This is possibly annoying to the advanced student, but it is a blessing to the general reader who may have forgotten or never have taken the necessary elementary studies.

Another uncommon feature is that the first time a new or particularised scientific word is introduced, its meaning is given in brackets beside it, thus: Colloidal (glue-like), Protophyta (means first plants), Paleobotany (means botany of ancient plants).

The book is in the main illustrated by the geological formations of the North American continent, rather than by reference to European formations. It gives, however, a clear and vivid account of the rise and sequence of the animal and vegetable life through geologic time, is well illustrated and includes with every chapter an excellent list of books for collateral reading.

Alone in the Sleeping Sickness Country. By FELIX OSWALD, D.Sc., F.G.S., F.R.G.S. (Kegan Paul, 6*s.* net.)

Doctor Oswald went out to Victoria Nyanza, in the winter of 1911-12, to examine a newly-discovered deposit of fossil bones on behalf of the British Museum. This is not the scientific record of his discoveries, but rather the chronicle of a scientist as a traveller.

The photographs are good and the book very readable even at this lapse of time since the expedition was undertaken.

Applied Chemistry. By IRA D. GARRARD, Ph.D. (The Macmillan Co. 15*s.* net).

Doctor Garrard has produced a book which is designed as a textbook for the use of the students of the New Jersey College for Women. It is a practical volume, covering a good deal of organic as well as inorganic chemistry, but it is very unusual as all the "applications" are selected, not primarily for their industrial importance, but rather according to their domestic function in modern life.

Nutrition and the chemistry of food is treated with cleansing agents, toilet articles, cosmetics, linen dyeing and bleaching, paints, varnishes and inks, all are used as illustrations.

It is an interesting book, and though it requires a knowledge of chemistry and biology rather seldom found in the housewife, it certainly gives an excellent general idea of the importance of applied chemistry from the housewife's point of view. It is perhaps due to its transatlantic provenance that so little space is accorded to alcohol. There is, however, an admirable section on yeast and the metrane esters used for artificial fruit flavours.

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